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JUNE 1955

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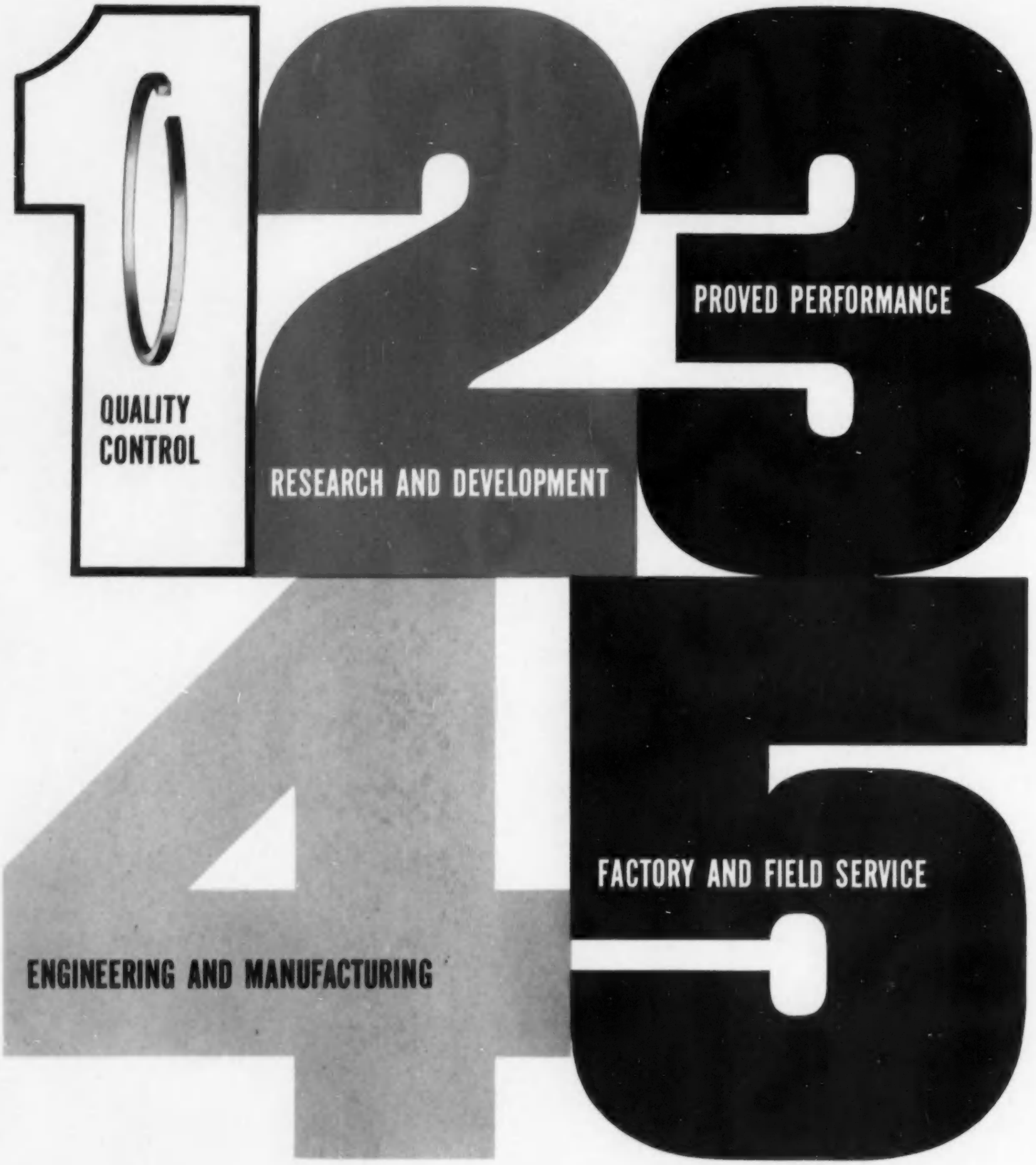

These are five important reasons for the *overwhelming* preference for Perfect Circles. And, 35 out of 37 manufacturers using chrome rings specify **PERFECT CIRCLE** piston rings!

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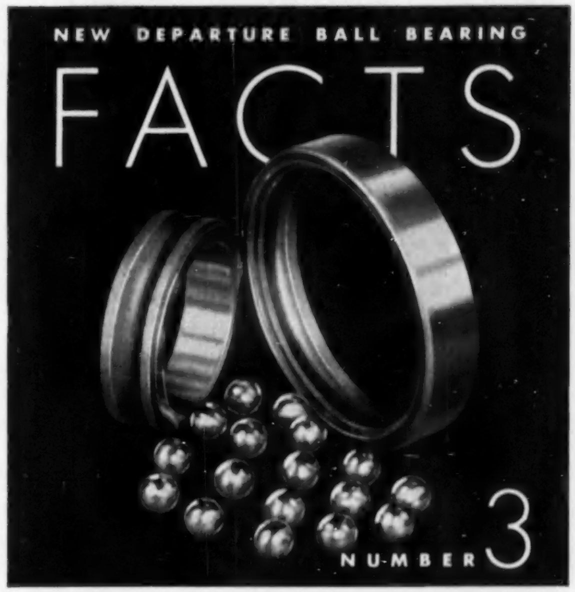
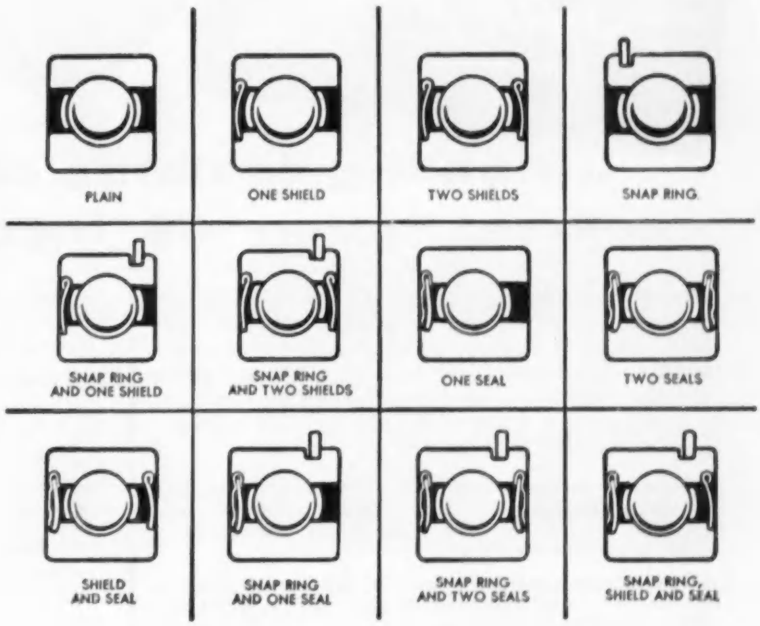


Versatile is the word for New Departure standard ball bearings! For these bearings may be obtained in a wide range of *standard* variations (as shown below), opening a tremendous range of uses to the engineer. In other words, a standard bearing has a "wardrobe" which fits it for very nearly any occasion!

New Departure Single Row Conrad-type bearings, with standard variations available, illustrate the "wardrobe" principle which makes these ball bearings, with their dual load-carrying ability, the most readily adaptable of all bearing types.



Virtually any mounting or operating requirement within a wide range of usage is met perfectly by a *standard* New Departure ball bearing, in conjunction with shields, seals, snap ring, or combinations thereof. Shields protect the bearing from ordinary dirt both before and after mounting and, in many cases, provide adequate retention of lubricant. Seals give positive protection against dirt of every kind and make possible enclosed lubrication for extended or even lifetime service. Snap rings allow positive location in housings lacking inside shoulders. Whenever a design or engineering problem involves ball bearings, think of New Departure. Highly experienced ball bearing engineers are always ready to work with you.

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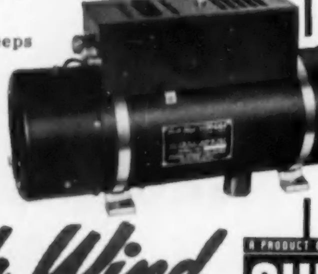

Two of these 30,000 BTU Heaters—Model 1030-D are standard on the Patton—

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Data given are typical for the 30,000 BTU heater — data for other sizes provided upon request.

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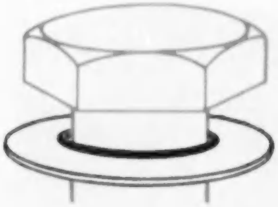
end leakage...have lock washer action with Precision O Dyna-seals



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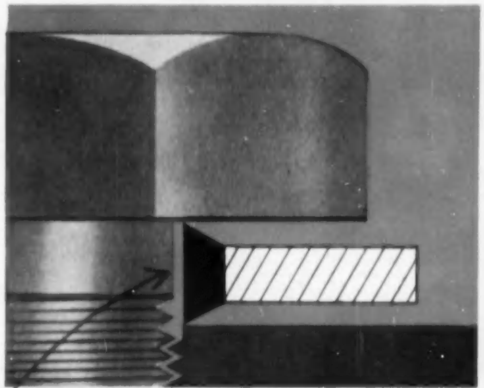
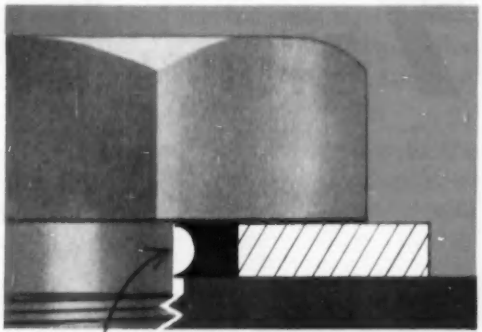


Note flare of rubber sealing member. When compressed under any type of bolt, flange or screw, it provides positive lock washer action, and reduces bolting torque.



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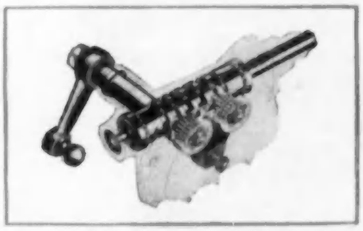

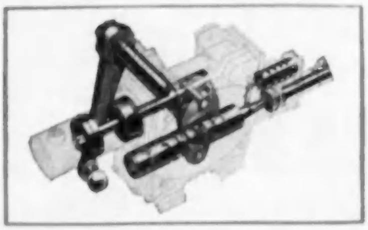

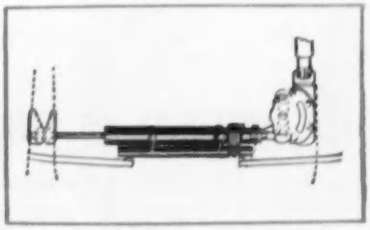

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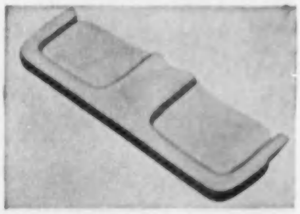
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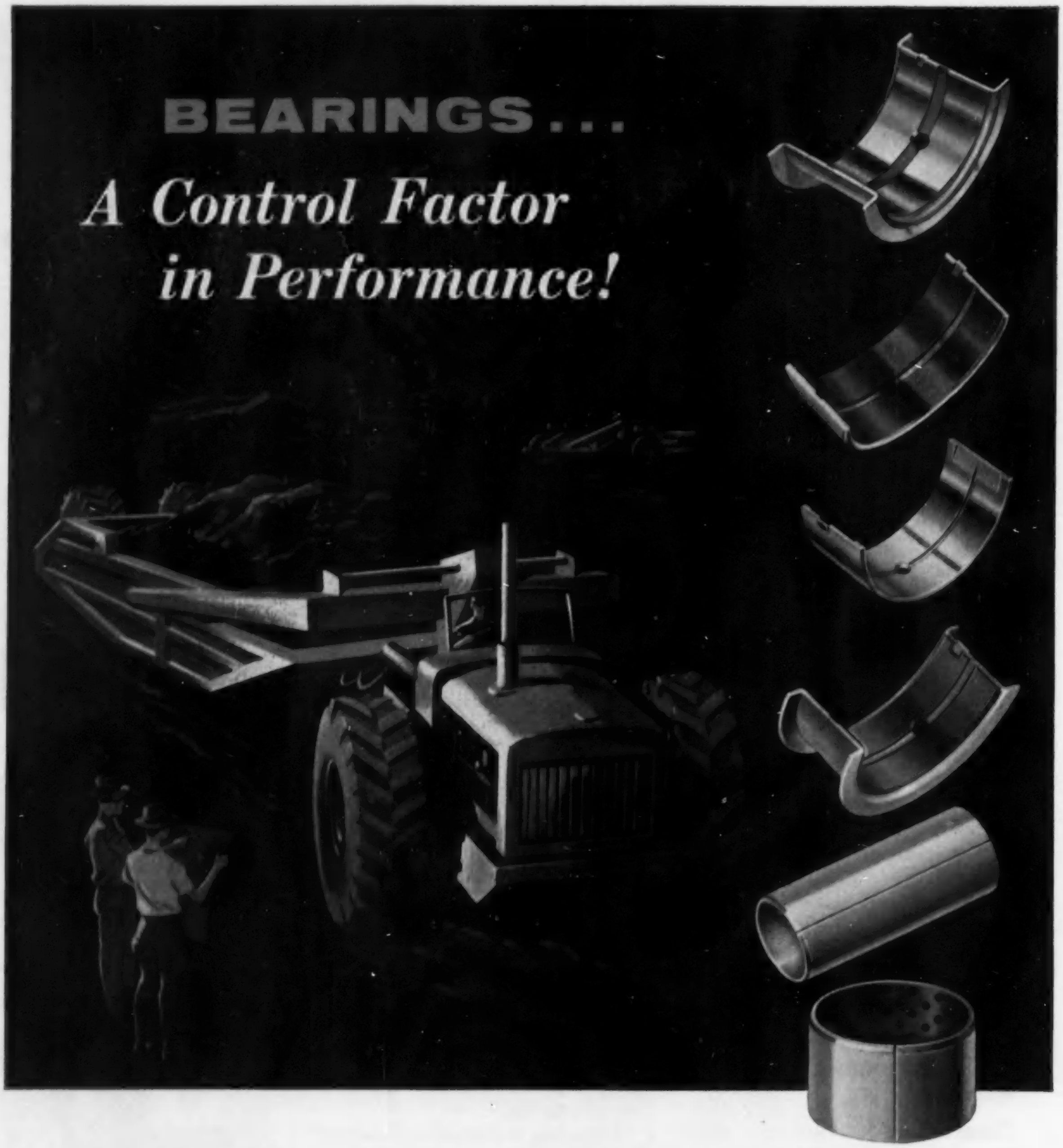

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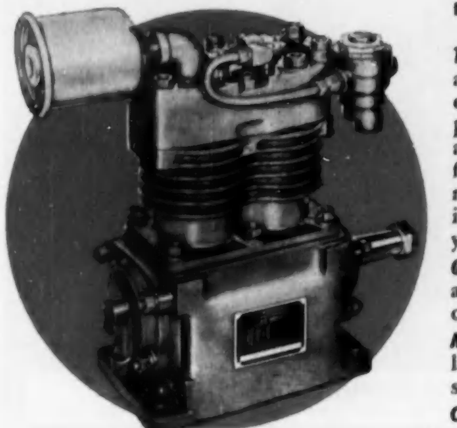

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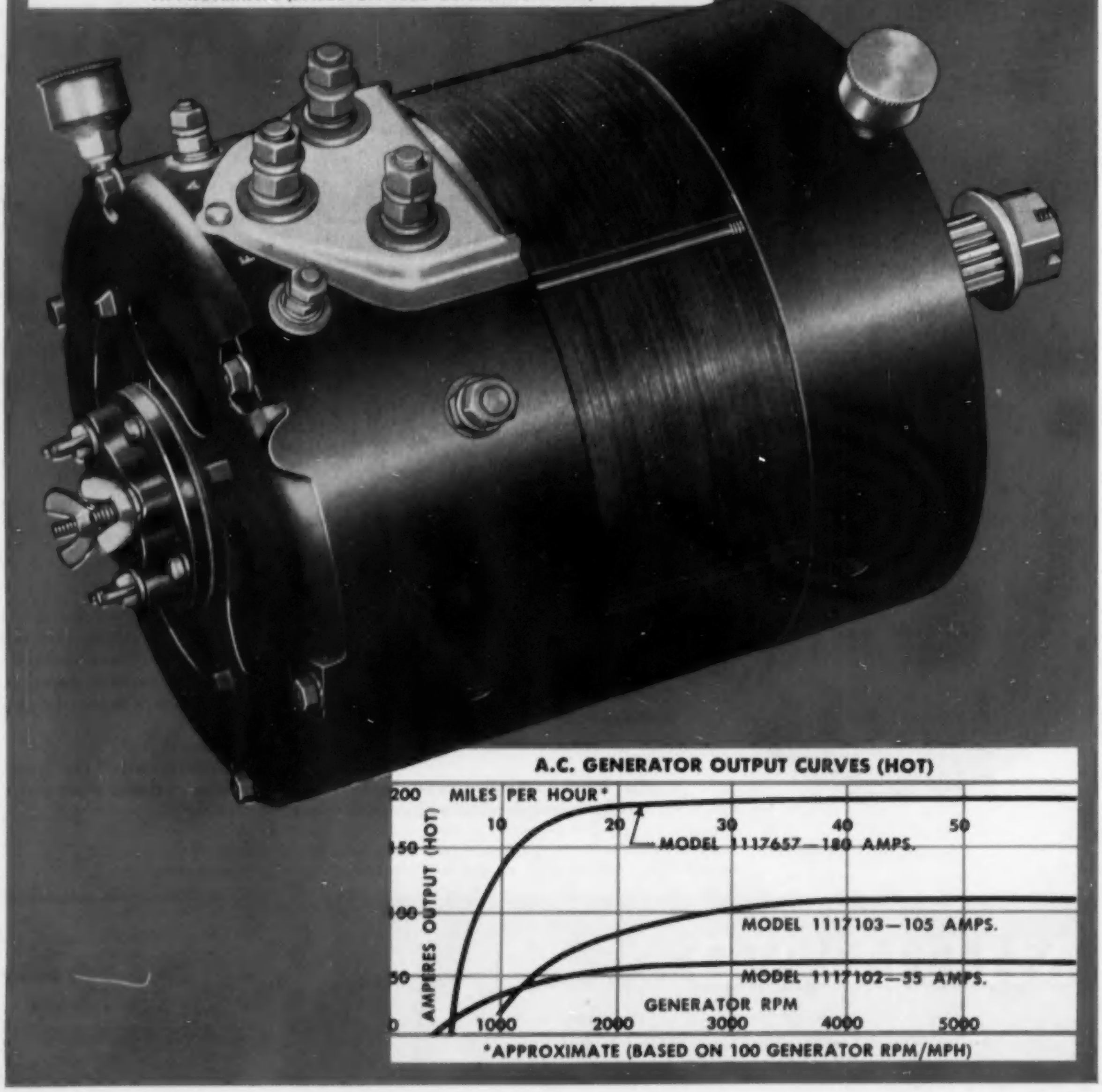
1117103	12	960	5	105	1575	All speeds.
1117657	12	550	130	180	2700	All speeds.
1117062-3-4	6	750	38	90	720	All speeds.
*APPROXIMATE (BASED ON 1000 GENERATOR RPM)						



Makes the Difference

DELCO-REMY'S NEW A.C. GENERATORS ANSWER THE WIDE VARIETY OF NEEDS IN HEAVY-DUTY APPLICATIONS

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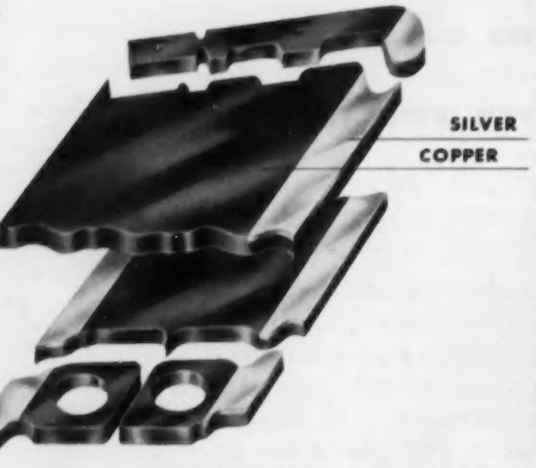
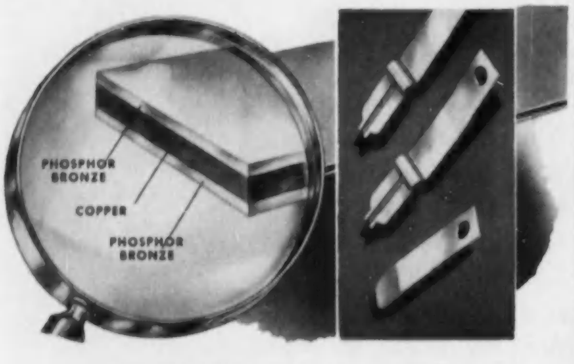
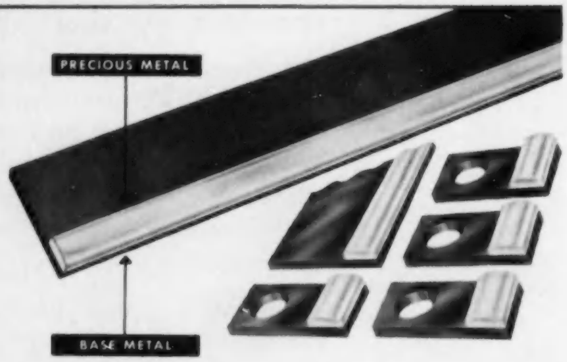


General Plate reduces fabrication and assembly costs of electrical switch contacts.

General Plate composite metal, coin silver clad to phosphor bronz, reduces material waste and manufacturing costs of electrical contact spring clips.



General Plate BRONCO provides higher electrical conductivity without increasing cross-sectional area of spring blades.*



General Plate TOP-LAY® provides quicker fabrication and longer wearing qualities in contact assemblies.

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For the Sake of Argument

The Meat on Which Group Action Feeds

By Norman G. Shidle

General Wavell once said:

"A disorderly mob is no more an army than a pile of building materials is a house."

A bunch of people working in the same company is no more an organization than a series of sounds is a symphony.

What makes people into an organization is clear understanding of a common aim—and a chance to participate in planning and performing to reach it. . . . But the common aim is the catalyst.

This aim must be specific enough in its nature and statement to preclude varied interpretations. Generalities inevitably mean different things to different people. The statement of aims must come as close as possible to having only one meaning.

Without a reasonably common understanding and acceptance of aims, groups of people never really become an organization.

And they become a smooth-flowing organization only as management and SUB-management supervisors keep showing to parts of the group—and to individuals—the relation of their every-day tasks to the aims.

Common objectives are the meat on which group action feeds. They are the food which nourishes cooperation, tolerance, and enthusiasm. Lacking them, cooperation, tolerance, and enthusiasm can starve and die for lack of something to chew on.

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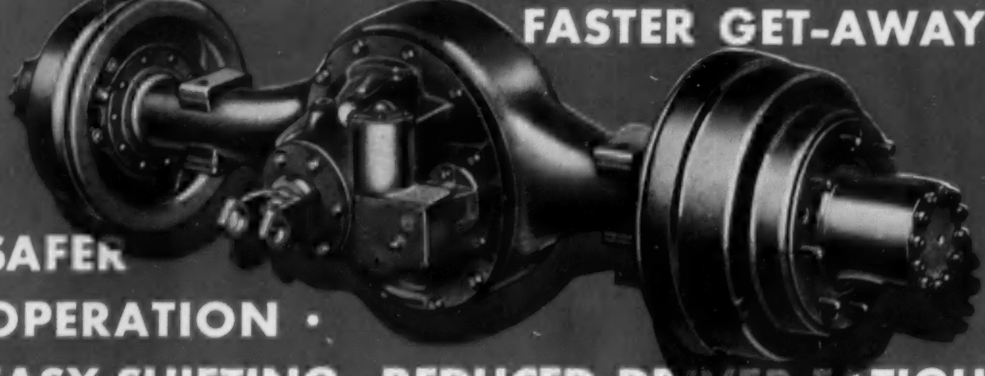

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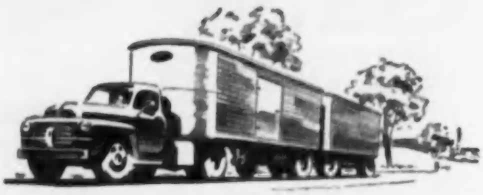

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Contents—June, 1955

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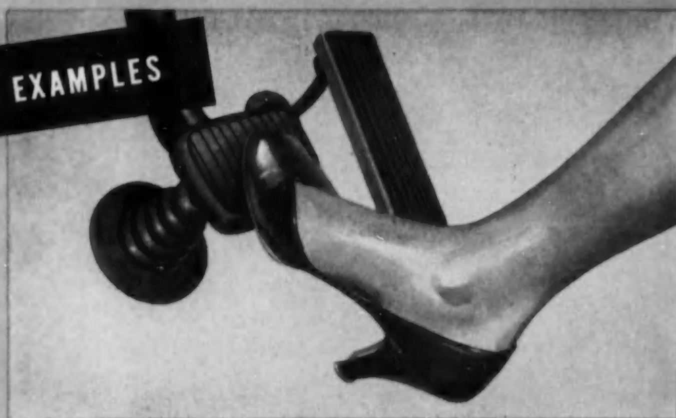

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Creativity in management

E. S. MacPherson, Ford Motor Co.

Based on paper "The Challenge of the 2005 Car," presented at the SAE Golden Anniversary Annual Meeting, Detroit, Jan. 13, 1955.

THE VALUE of the creative mind in an engineering organization is unquestioned. It is the creative mind which produces the new ideas that result in new consumer demands and more business. On the management level creativity is a prime requisite.

In recent years, individual inventiveness has been replaced by organized creativity, such as company research departments, engineering task forces, and scientific project teams. Management's challenge of the future is to increase the potential creative forces inherent in these groups. We must successfully guide creative individuals within these larger organizations without submerging individual creativeness. We must stimulate creativity by providing a favorable atmosphere, and at the same time, apply the controls necessary to keep business risks low.

This presents many problems because the amount of creative atmosphere is usually inversely proportionate to the amount of business controls and the size of the organization. But, by applying what Henry Ford II has called "human engineering," the challenge can be met.

There are neither formulae, nor proven principles of "human engineering" for establishing an ideal creative atmosphere. However, experience with large creative organizations enables us to make observations which management may find helpful.

Creating Creative Management Personnel

To reduce risk in a highly competitive industry, management tends to depend upon business statistics and to cater to business demands during design planning instead of trusting creative intuition. The danger of this is obvious: all manufacturers may arrive at the same decisions and designs. (Evidence of this can be seen in the similarity of current American automobile designs.)

Because of the business demands of his job, an engineering manager often overlooks or fails to support enthusiastically a good, new idea conceived in his organization. He may also be reluctant to delegate responsibility and authority to subordinate creative engineers. Consequently, his organization loses enthusiasm and job devotion—both so essential to creativity.

The pressures of business invariably predominate throughout research, advanced engineering design, and product engineering—unless the engineering management has a creative orientation.

Unfortunately, the qualities of "businessmanship" and "creative ability" are rarely found in one man. So, when selecting management personnel, we are forced to make a choice of one type or the other. Usually the man with executive ability is selected for advancement. Yet we know that inevitably, the domination of this singular quality destroys the primary function of the engineering organization—creating—and in turn, betrays its obligations to business management.

Certainly the most important quality required for engineering management is creative ability. We must choose the individual with the most creative ability; then we can cultivate his latent executive

In an effort to reduce risk, we have become overdependent upon facts and too independent of the creative mind

We must increase the potential creative forces inherent in the large engineering organization

We must provide an atmosphere conducive to creativity

Latent executive ability can be cultivated; individuals cannot be taught to invent

Creative ability is the primary quality required for engineering management

qualities. Of course, this must be done early, before the full qualities of a mature executive are required. He must be exposed to business demands gradually and learn to understand and cope with them.

By understanding the systems of business, he will never become buried in those systems. His creativeness will always question why, and suggest changes. And his administration will be flexible, efficient, and understanding.

We must trust these individuals and accept their constructive criticism of our systems and procedures just as we acknowledge their inventions.

It is true that some of our best creative minds have disdain for business discipline. But they should realize that their existence depends upon the business exploitation of the ideas, not on their ideas alone.

Cultivating latent executive ability in the creative individual, delegating responsibility and authority, and sponsoring new ideas are closely interrelated. Obviously, the time used by management to sponsor new ideas demands delegation of business problems. These problems should be disassembled and delegated to successive levels of management the same way we disassemble and delegate automobile designs. Each scientist, engineer, or designer is assigned his element of business discipline (schedules, reports, costs, personnel, etc.) along with his portion of the creative design problem. Naturally, our systems and procedures must be devised so that the creative individuals can operate effectively with all of these variables, in addition to the technical variables.

Aside from knowledge of the job and the above requirements for a good manager, the only other requirements are emotional stability and maturity. However, the importance of youth as a part of creative management cannot be over-stressed. The inventive capabilities of young men are illustrated in the history of science and invention. Of course, a combination of youthful thought-processes in an older, experienced man is a very valuable asset.

With a management that has the qualities that provide for a positive, creative atmosphere within which the individual can work with minimum frustration and maximum stimulation, we will open vast areas of creative potential. We will no longer be accused of "trampling ideas," or more seriously, "picking brains." Our creative personnel will become more productive and will be happy to stay with our organization.

(Paper on which this abridgment is based is available in full in multilith form from SAE Special Publications Department. Price: 35¢ to members, 60¢ to nonmembers.)

Based on discussion . . .

T. H. Thompson, Sabre Research Corp.

I do not believe that the era of the individual creative inventor is past, although it is true the ultimate commercial refinement of the invention probably will be the product of large engineering organizations.

The invention is the end-product of an elimination process on the part of the individual inventor. Its excellence is measured by how closely the inventor approaches ultimate perfection by this process.

Every engineer is a potential inventor, depending upon how much effort he channels into the inventing process. An undisciplined, creative mind will not necessarily disrupt an organization; he might move it out of a rut and onto new paths.

Compression Ratios . . .

. . . as high as 10:1 are feasible if 98-99 Research Octane fuel of the proper volatility is used in conjunction with a multi-viscosity lubricant.

Based on paper by **C. L. Fleming, Jr., N. V. Hakala, L. E. Moody, R. W. Scott, and C. O. Tongberg,** Standard Oil Development Co

USE of volatile fuels and multi-viscosity lubricants should make possible the increase of compression ratios without a corresponding increase in antiknock quality.

This is one of the conclusions reached from a controlled field test to see if deposit formation, already effectively minimized by use of multi-viscosity lubricants, could not be further reduced by improvement in the fuel.

Two premium type fuels were used. One was of average back-end volatility with 90% evaporated at 347 F, while the other was a more volatile type with 90% evaporated at 302 F. Both contained approximately 50% catalytically cracked stocks, but the

more volatile had about 10% of high boiling components omitted. The multi-viscosity lubricant was an SAE 10W-30. And the evaluation was made in eight 1953–54 model cars.

The first finding was that octane requirement increase contribution of the fuel can be substantially reduced by elimination of the higher boiling, thermally unstable hydrocarbons. This fuel development is at least equal in importance to the development of the multi-viscosity lubricant.

When comparison was made between a combination of a conventional lubricant and average volatility fuel with that of a multi-viscosity oil and a volatile fuel, the latter was found to give a much lower equilibrium octane requirement. Based on an average of eight cars on each combination, there was a 5.7 octane number advantage for the combination of a volatile fuel and multi-viscosity lubricant, while the average for individual cars varied from 4.0 to 8.5 octane numbers.

To investigate the importance of octane requirement increase and the occurrence of surface ignition in future-type high-compression-ratio engines, four engines with standard ratios ranging from 7.5/1 to 8.25/1 were converted to nominal 9.5/1 and 10/1 compression ratios. On city-suburban driving tests three out of four cars gave a completely satisfactory performance with the volatile fuel and multi-viscosity lubricant. The reason for unsatisfactory performance of the fourth car is not known and is being investigated, but it might be due to peculiarities of combustion chamber design.

In these high compression engines, using conventional fuel and lubricants, the antiknock quality of the fuel would have to be 100 octane or more to meet the high octane requirements imposed by the fuels and lubricants. (Paper "Control of Engine Knock Through Gasoline and Oil Composition" was presented at SAE Golden Anniversary Annual Meeting, Detroit, Jan. 11, 1955. It is available in multilith form from SAE Special Publications Department. Price: 35¢ to members, 60¢ to nonmembers.)

Based on Discussion . . .

J. J. Mikita,
E. I. du Pont de Nemours & Co., Inc.

We have obtained similar results in laboratory studies with multi-cylinder engines modified to 9/1 and 10/1 C.R. Commercial type fuel and a distillate-residuum blend lubricant were prone to cause surface ignition. Switching to an all-distillate oil, or to a synthetic oil, decreased surface ignition markedly. When, in addition, a switch was made to a clean-burning fuel, surface ignition was virtually eliminated.

Harold J. Gibson,
Ethyl Corp.

Tests with a single-cylinder engine on a wide variety of 5W-20 and 10W-30 multi-graded oils indicate that, relative to our baseline SAE 20 oil, the oils ranged from no effect on requirement increase to a reduction of about 30%. This indicates that an oil is not necessarily good in this respect just because it can be multi-graded.

H. A. Bigley, Jr.,
Gulf Research and Development Co.

We question that the multi-viscosity characteristics of the oil tested were alone responsible for the beneficial results. Is it not possible that synthetic oils, or conventional oils without bright stock, might be similarly effective in reducing equilibrium octane requirements?

Wrap-Around Windshield . . .

. . . represents culmination of research effort beginning with laminated glass, and running back to 1885. Safety preceded style in the process of perfecting.

Based on paper by **George B. Watkins,** Libby-Owens-Ford Glass Co.

THE panoramic windshield is but the latest in a series of landmarks in the development of the automobile windshield.

Laminated glass had its inception 70 years ago when patents were taken out in England for the manufacture of plate glass in sandwich form for church and cathedral use. Laminated safety glass, forerunner of today's automotive glazing, did not appear until 20 years later. The first patent was taken out in England in 1905. Benedictus, a Frenchman, capitalizing on the idea took out patents in both England and France in 1910.

The second landmark was established when polyvinyl butyral plastic was created for the interlayer of the sandwich. This made a better product and, in addition, simplified production by eliminating edge-sealing. This happened as recently as 1939.

In 1947, the third landmark was reached as a result of research into glass compositions which led to the development of heat-absorbing glass. Shortly thereafter developments began in the production of curved safety glass, culminating in the panoramic windshield of 1954.

The satisfactory optical results achieved in the panoramic windshield came about through trial and error, which entailed numerous dimensional adjustments, road tests, and motion picture studies. (Paper "Improved Vision with Panoramic Windshields" was presented at SAE Detroit Section Meeting, Toledo, April 11, 1955. It is available in full in multilith form from SAE Special Publications Department. Price: 35¢ to members, 60¢ to nonmembers.)

How to Get Your Man Out

...this is the aircrew escape problem created by high speeds and altitudes

THE simplest way for a pilot to escape from his airplane and avoid its tail is to roll the plane upside down, open his lap belt, and fall out. The trouble is, it doesn't always work, especially with fast aircraft. The crew of an airplane in an uncontrollable spin would be pinned to their seats by the 2 *g* forces acting on them and there is not always time to roll a plane on its back.

To get around this difficulty, the ejection seat was developed, propelled variously by springs, compressed air, gunpowder, and rockets. A rocket-propelled seat accelerates more gradually than one fired by gunpowder, but it gains speed after it leaves the ship. This is dangerous because of the instability of the seat as it enters the slipstream. It begins to pinwheel murderously and the rocket might drive it back toward the aircraft.

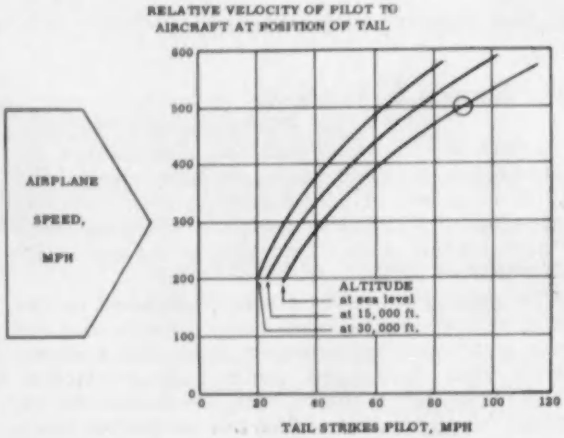


Fig. 1—A pilot leaving a 500-mph airplane will be slowed to 90 mph in traveling the distance from cockpit to tail and the tail will hit him. The curves also reveal that the relative speed of pilot-to-tail is affected by the altitude at the moment of bailing out.

As a pilot leaves the cockpit he is subjected to the full force of the wind resulting from the forward motion of the aircraft. At 500 mph, at sea level, the impact force on an upright man is approximately 5000 lb. This force decelerates the pilot with respect to the forward velocity of the airplane. At 500 mph he is slowed to 90 mph in traveling the distance from the cockpit to the tail and so the tail will strike him (Fig. 1). Furthermore, the relative speed of pilot-to-tail is affected by the altitude at which he bails out.

And there are other factors hard on the human body. Captured German photographs (Fig. 2) show what happens when you face into a 300 mph breeze. If the face is unprotected the eyelids are forced open and raised like umbrellas. Above 400 mph the mouth must be kept tightly shut or the air will force it open as shown in Fig. 3, and may destroy the lungs by over-inflation. Above 500 mph the slipstream may lacerate the face.

A man can stand 20 *g* ejection acceleration provided he sits erect, but if his vertebra is arched, spinal compression injuries will result. Human tolerances to ejection forces are the chief limiting factor in ejection seat design. The velocity must be great enough to get the man past the vertical stabilizer, but not great enough to injure him.

The ejection seat does enable the pilot to avoid

All in One Piece

William Bonas and M. J. Reilly, The Glenn L. Martin Co.

Based on paper "That First, Long Step—Problems of Aircrew Escape," presented at SAE Golden Anniversary Annual Meeting, Detroit, Jan. 11, 1955.

the tail, but it also raises the minimum safe altitude for bail-out. As he sails through the air after ejection he must slown down until the deceleration forces no longer immobilize him. Then he must unfasten his lap belt and shoulder harness and kick himself free of the seat. Once in the clear, he must fumble around for the parachute "D" ring and pull the rip cord. It all takes time and at low altitude a second or two may mean the difference between life and death.

Automatic devices now gain these precious seconds for the pilot. A new safety belt is unbuckled automatically by a time-delay device after the seat leaves the ship, while another time-delay mechanism, or static line, opens the parachute. Automatic equipment is essential to the survival of an uncon-

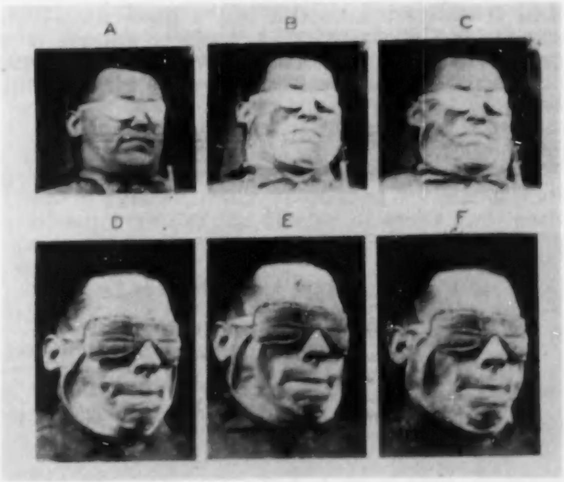


Fig. 2—Captured German photographs show what happens when an aircrew member faces into a 300 mph breeze. Note what happens to the cheeks. If the eyes weren't protected, the 300 mph wind would force the eyelids open and raise them like half umbrellas.

Fig. 3—This is what happens to a man who fails to keep his mouth shut tightly at 400 mph. Having forced the mouth open, the air may overinflate and destroy the lungs.

scious crew member of a high altitude bomber. Aneroid actuators in the seat and parachute release mechanisms allow him to fall free through the rarified atmosphere before the parachute opens.

Bomber crews fly above 40,000 ft where the temperature hovers around −100 F and the air is too thin to offer resistance to a plummeting body. A man would reach such high speeds in his fall that if he tried to open his parachute the shock would kill him or shred the canopy. Moreover, he would probably freeze to death or die from lack of oxygen before reaching the lower altitudes where life can be sustained. The aneroid mechanism opens the parachute at approximately 10,000 ft, thus saving the injured or blacked-out crew member who cannot pull his "D" ring.

As aircraft approach the speed of sound, the problems of windblast, tumbling, and deceleration become more acute. A man can't hold on to the hand grips above 400 mph because the air pressure against his forearms severs his hold and flings his arms backward, often breaking them. Above 500 mph, the high-velocity air will fling his legs outward, even with knee guards, tearing them from their sockets. So getting a man out of his ship is not enough; the problem is now one of getting him out whole. It might be possible to do this with limb-retention provisions on a standard ejection seat, comprehensive pressure suits, or we might investigate escape capsules of which there are three basic types.

The "baby carriage capsule" is the simplest type. Both pilot and seat are enclosed in shell-like hoods which form a water-tight pod that will float if it lands on water. It is ejected in the same manner as an ejection seat, but a built-in parachute lowers it to the ground.

The second type, like that shown in Fig. 4, is larger and includes the complete, pressurized cockpit with windshield, canopy, seat, control stick, rudder pedals, instrument panel, and oxygen system. It is ejected by catapult or rockets, stabilized by fins after separation, and lowered by parachute.

The third and ultimate in capsule design comprises the entire nose section of the aircraft. It is separated from the ship by explosive bolts and rockets, stabilized by fins, and lowered by parachute.

The capsule protects the crewman from the wind's force when he escapes at low altitude from a high speed ship, and provides a warm, pressurized atmosphere for high-altitude escape. But it doesn't end all troubles. Anything as unstable as a cockpit, propelled at right angles to the path of the air, will have its direction and speed altered violently. It will tumble at a rate of rotation which depends on the speed of the aircraft, the non-symmetry of the capsule, and the point at which the ejection force is applied. Consequently, time will be required for deceleration and stabilization and this will raise the minimum safe altitude for escape.

There is also the question of how much a man can stand in the way of high *g*'s encountered from the ejection force, deceleration, and centrifugal force of tumbling. That is what we are in process of finding out.

As new safety equipment is developed it becomes heavier and bulkier. This hinders performance, and so we find that if the ejection seat is insufficient for safe escape, a capsule may be too heavy. We are faced with a dilemma which may compromise either our airplane performance or our safety provisions. The only way we can avoid this is through increased powerplant efficiency, greater knowledge of fluid dynamics, and intensified research into escape equipment technology. (Paper on which this abridgment is based is available in full in multilith form from SAE Special Publications Department. Price: 35¢ to members, 60¢ to nonmembers.)

Based on Discussion . . .

Major Philip J. Maher, U. S. Air Force

Comparative analysis of ejection and conventional bail-outs favors the ejection seat heavily. But aircraft altitude at time of ejection is an important consideration in any discussion of successful versus unsuccessful ejections. Attempts to escape from aircraft in a dive are only 50% successful. The ejection process takes from 7 to 12 sec, provided there are no difficulties. An aircraft in a 60-deg dive at 500 knots, 8000 ft above the terrain, will strike the ground in 11 sec. Under these conditions, and considering altimeter lag, a pilot must leave the aircraft above 10,000 ft altimeter altitude if he is to have any chance of success. It is unlikely that an escape capsule will assist materially in this problem.

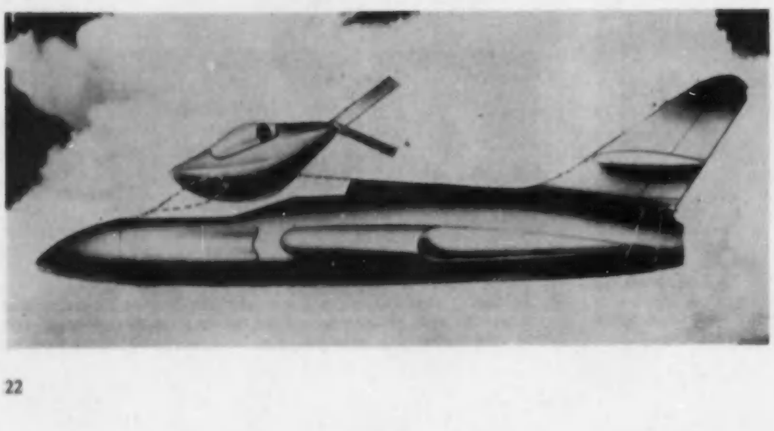


Fig. 4—An escape capsule represents one device to bring pilots down to earth whole. It is ejected by catapult and rockets, fins stabilize it after its separation, and a parachute lowers it to the ground.

Punched Cards Make Feasible

Integrated Manufacturing Control

K. Porteous, Industrial Engineer, Lockheed Aircraft Corp.

Based on secretary's report of panel on Tabulating in Industry held as part of the SAE Aircraft Production Forum, Los Angeles, Oct. 6, 1954.

WITH punched cards—and the proper tabulating and calculating equipment—you can perform each of the data-handling routines required in manufacturing control.

With punched-card routines—and a properly planned flow of data—you can integrate all the elements of the manufacturing control system. The chart on the following page shows how it can be done for the manufacture of an aircraft.

The advantage of integrating the manufacturing records is that it minimizes the number of breaks in the chain of data processing. The fewer the breaks, the fewer hours spent in laborious key punching from source documents.

An integrated, fully automated system of data processing reduces the number of errors and speeds the flow of information. It saves money all along the way.

Punched-card routines make it simple to:

1. Record data in a form easy to manipulate when selecting and arranging document content.

2. Print information contained in card files without resort to another writing machine.

3. Calculate as a part of the data processing operation.

Many data-processing routines involve only Functions 1 and 2. Parts listing is such a routine. The third function, calculating, is involved in routines such as scheduling, order writing, and inventory control.

Mechanized data processing can be applied to just about any routine where parts and materials are identified by numbers. If aircraft manufacturers and their suppliers can adopt uniform part numbering systems, application of mechanized data processing will be easier.

Some of the individual elements of the manufacturing control systems are considered in the following paragraphs.

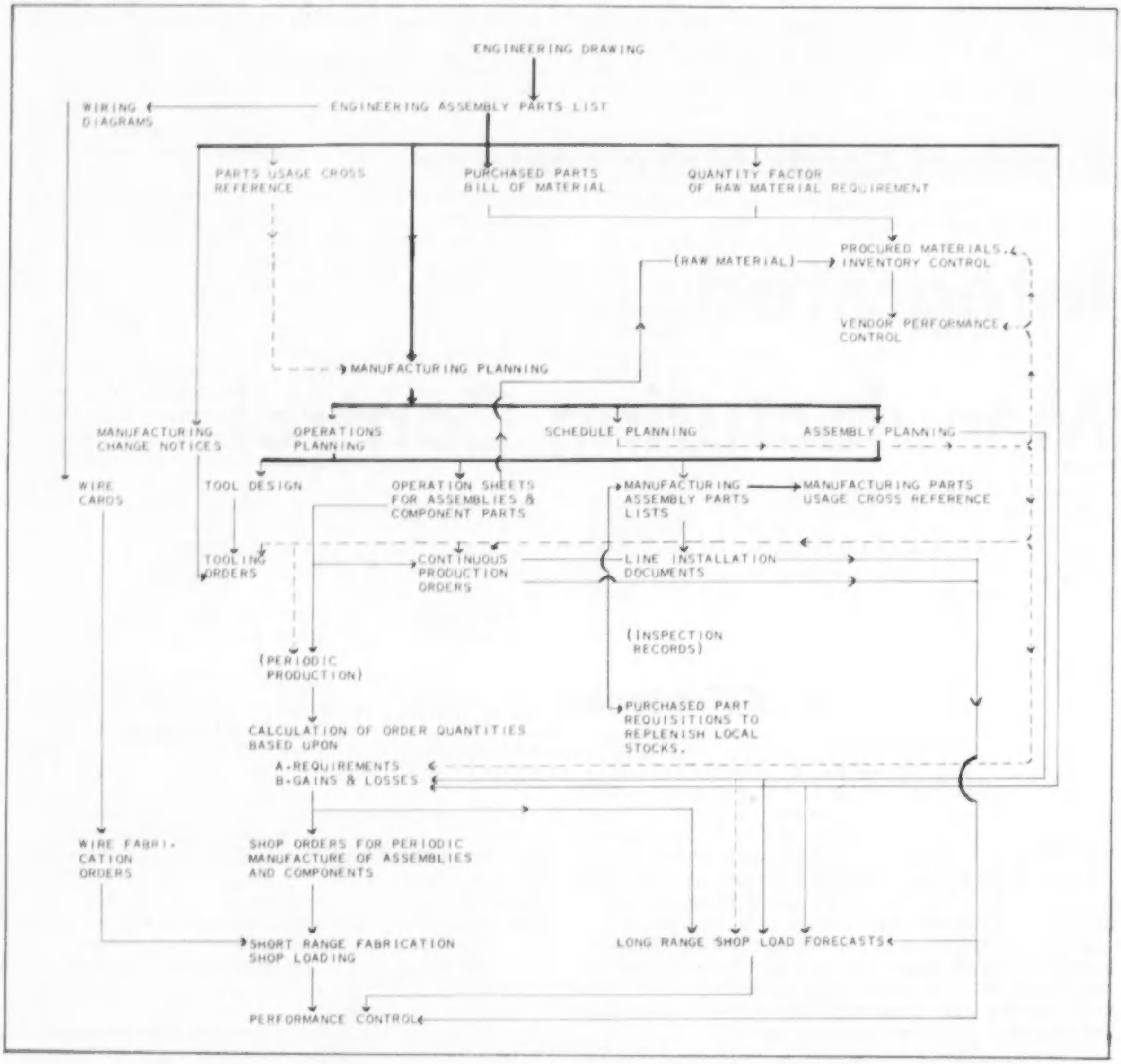
Assembly Parts Lists

First step is to scan the engineering drawings and establish a punched card for each part. These cards constitute the engineering assembly parts list.

A second parts list arises from the industry practice of reworking engineering assemblies into configurations better suited to shop practices of manufacture. Existence of two separate parts lists is a fundamental source of confusion. Yet the successive listing of parts following completion of the design stage and the manufacturing-planning stage will probably exist as long as these two functions are performed separately.

The confusion arises because both parts lists are subject to constant change.

An engineering parts list, in fact, may consist of a basic list of parts selectively modified by subsidiary lists representing the needs of different customers.



THIS IS THE PATH WHICH INFORMATION FOLLOWS FROM THE ENGINEERING DRAWING THROUGH MANUFACTURING

Changes of part number, quantity, ship serial limits, and the like are constantly being introduced into the engineering parts list. These must be traced to the affected manufacturing assembly configurations. At the same time the manufacturing assemblies are being reshuffled to take advantage of shop experience. Hence, it is vital to control these changes to working records.

The situation becomes even more confused when the additions or deletions of individual parts incident to the shuffling or modification of assembly components are not coordinated in point of time in either or both parts lists.

When punched cards are used to generate shop order quantities from parts list usage under ship serial limitations, the uncoordinated release of changes can cause the development of incorrect order quantities because of the deletion from the parts list of assembly components before the placement of the same components has been recorded on drawings for other assemblies and parts-listed as additions thereto.

Various schemes have been developed to effect a reconciliation of the engineering and the manufacturing parts lists. Some of these place the responsibility with the manufacturing planner (where it is not usually welcomed). Others make the operation an after-the-fact clerical audit.

One novel plan provides for a code to be applied by the engineer, to indicate whether the deletion of parts from any one assembly is final or is being done to transfer the parts to another assembly.

Whatever the general plan of reconciliation may be, the operation is facilitated by the availability of

punched cards or by assembly listings and cross-reference listings made from the cards.

Wire Control

Recording the 10,000–20,000 wires required in a typical modern airplane is much like making up a parts listing of other components of the airplane, with some peculiarities added. To begin with, an incomplete work sheet is formulated manually from the circuit diagram. As the mockup progresses, the work sheet is checked and completed, wire by wire. Then tabulating cards are punched from the work sheet.

From these cards is printed a wire data sheet. This becomes a work sheet for the recording of subsequent changes. When a wire is deleted, its card is removed from the file. A new card is made up to correspond to the replacement wire. Then a new wire data sheet is run off.

Wire cutting tags are prepared by the tabulating department as the production schedule requires. Later various listings of wires are made from the punched cards to provide the procurement department with material requirements and customers with wire data.

Applying this system of punched-card wire data control allowed one aircraft manufacturer to transfer 25 employees to other duties and also improved overall accuracy.

Periodic Production Schedules

Where demand doesn't warrant continuous production of a unit and it is therefore to be produced periodically in batches, punched-card techniques are useful in several of the scheduling steps. One company does it this way:

1. Determine the number of schedule base points (positions) suitable for the planned rate of production.

2. Determine a start date for each airplane at each position.

3. Determine the position at which each assembly enters the line, so as to relate it to some airplane serial number and line date.

4. Assign an airplane serial date to each position.

5. Enter the position number of each assembly into each punched card for the part numbers which are the components of the assembly.

6. Establish a time span for each in-line periodic subassembly. Establish time span for fabrication. Determine the number of stepbacks from the base position for each part number.

7. Calculate required lot quantity for each usage of each part number.

8. Summarize all usages of each part number, and identify to the "position" number of the assembly, with the earliest date for the first ship number of the ordered lot.

9. Originate a set of punched cards bearing a start date and completion date for each setback from each possible position.

10. Apply to each summarized requirement card the dates appropriate to the position and setback recorded in the card.

The panel of tabulation experts who led the discussion on which this article is based consisted of:

F. C. Carlin, panel leader
Lockheed Aircraft Corp.

W. E. Wheeler, panel co-leader
Northrop Aircraft, Inc.

K. Porteous, panel secretary
Lockheed Aircraft Corp.

W. P. Bamrick
Douglas Aircraft Co., Inc.

C. H. Buse
Convair Division, General Dynamics Corp.

R. G. Canning
University of California at Los Angeles

C. C. Coleman
Lockheed Aircraft Corp.

F. J. Knight
Convair Division, General Dynamics Corp.

Labor Forecasting

Electronic data processing machines are ideal for the complicated job of calculating labor hours. The forecaster first selects the part numbers that will be in process during a specific period of time in a specific area. To these he applies detailed time schedules and calculates the numbers of hours required for each operation.

Even with electronic data processing the calculations are not easy. But manually they would be practically impossible for anything like an aircraft plant.

To the figures from the electronic calculator can be applied factors reflecting change in work content due to "engineering growth" (design change) and to the learning effect.

When labor forecasting is done with punched cards, forecasts tie in directly with production scheduling routines, shop order procedures, and parts lists also recorded on punched cards.

Punched-card techniques of mass forecasting are, however, too cumbersome for close-range, day-to-day fabrication shop loading. A close-range, manually operated load program, derived from actual orders at hand, coupled with a punched-card long-range projection beyond the reach of released orders makes a good working setup.

(The report on which this article is based is available in full in multilith form together with reports of the nine other panel sessions of the 1954 SAE Aircraft Production Forum. This publication, SP-309, is available from SAE Special Publications Department. Price: $2.00 to members; $4.00 to nonmembers.)

Growing Truck, Bus Market

Potential operating economies in commercial and military vehicles are strong incentives for switching to hydraulic transmissions

THE hydraulic transmission—in one form or another—looks like the coming transmission for many types of future commercial vehicles. Reasons: it makes for better use of available horsepower, protects engine and vehicles from inexperienced drivers, and there's a potential improvement in fuel economy.

In the survey out of which these conclusions grew, we determined the relationship between gross vehicle weight, transmission ranges, ratio steps, and gross horsepower.

We also studied different engine types on the basis of speed variation (ratio steps) versus different percentage values of allowable minimum horsepower. Speed variation is a governing factor in selecting gear ratios for desired horsepower available.

The vehicle groups studied were:

- Buses
- Military vehicles
- Delivery trucks
- On-highway trucks
- Off-highway trucks

All the indications from these studies point to one conclusion . . . the hydraulic transmission is rapidly approaching for these vehicles.

1. How Power-Weight Ratio Affects Transmission Needs

For all practical purposes, the potential ability of any vehicle may be rated by the power-weight ratio. Fig. 1 shows the average gross horsepower per ton for each group of vehicles investigated. Each value was arrived at by plotting the number of units in different power-weight ratio zones and then averaging the complete band.

- 20 hp per ton for buses
- 18.75 hp per ton for military trucks
- 13.0 hp per ton for delivery trucks
- 7.0 hp per ton for on-highway trucks
- 6.0 hp per ton for off-highway trucks

This power-weight ratio affects transmission requirements in each type of vehicle operation. Investigation showed that the bus field, including both the transit (city service) and parlor coach (intercity service), has a high power-weight ratio in most applications. In city service, where acceleration is very important for stop-and-go operation, a high rating is needed to obtain this kind of performance. The power-weight ratio is of sufficient magnitude to require only three to four transmission speed ranges in the smaller vehicles.

In the larger transit coaches, the hydraulic torque converter is the most prominent transmission in use today. It lends itself ideally to use as a means of accelerating the vehicle up to a speed where it can be handled by the engine in direct drive. The converter allows continuous shock-free acceleration without shifting gears. This feature is of particular value in transit coaches operating on stop-and-go type of service . . . where the driver is burdened with fares, change, transfers, personnel management, and traffic problems. Operational

Ahead for Hydraulic Drives

R. M. Schaefer,
Manager, Transmission Engineering Department, Allison Division, GMC

Excerpts from paper "Transmission Developments for Trucks and Buses" presented at SAE National West Coast Meeting, Los Angeles, Aug. 18, 1954.

safety, smoothness, and simplicity of single throttle controlled automatic drives have paid large dividends to both operators and passengers.

In parlor coach service a high power-weight ratio is advantageous because of the highway operation in hilly country with numerous grades. With time schedules very important, the minimum use of the transmission helps the driver maintain good service. At the same time the operator must have at his disposal sufficient gear ranges to operate on long steep grades at reasonable speeds. Also, like the transit coach, the parlor coach must be able to accelerate rapidly in dense city traffic. Most of the coaches in this type of service use five-speed transmissions.

In this same area of high power-weight ratio is military trucks. This type vehicle uses its high rating for negotiating steep grades and operating

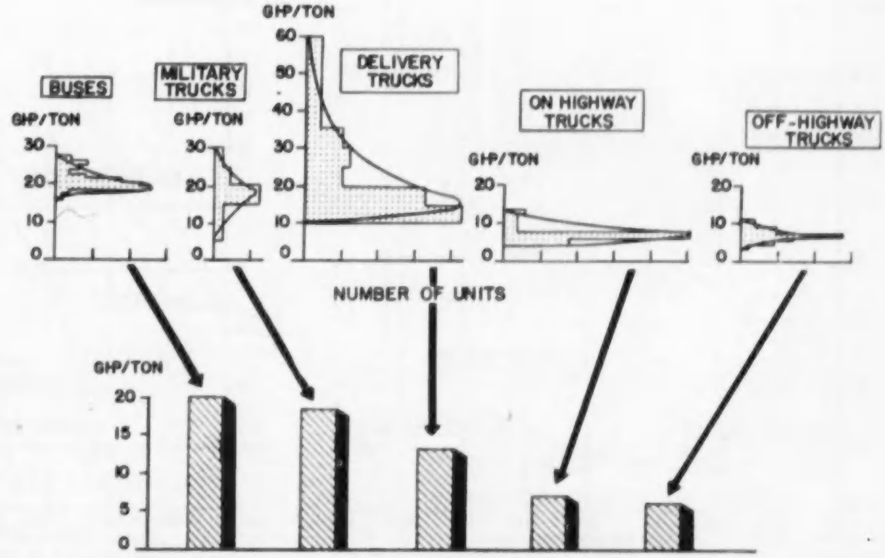


Fig. 1—Buses generally have a higher power-weight ratio than other commercial and military vehicles, investigation showed.

over rough, undeveloped terrain in all kinds of weather. In addition to required excellent gradeability performance, this group of vehicles also must be able to develop moderate speeds when operating on good level roads. To have this flexibility, three to six speed ranges are generally used to allow the maximum speed on level roads and to permit grade operational requirements.

In delivery trucks (½ to 2 tons) for city driving and country operation, the power-weight ratio in most of these units is of sufficient magnitude to require only three to four transmission speed ranges to satisfy the requirements of this type service.

The next group of vehicles examined was the on-highway trucks. Here the power-weight ratio was less than one-half the values found in the delivery, bus, and military vehicles. With this kind of rateability, the transmission becomes a very important component when considering the operating requirements for these trucks. The transmission ranges were found to vary from 5 to 12 successive steps, depending upon the vehicle weight and size of engine.

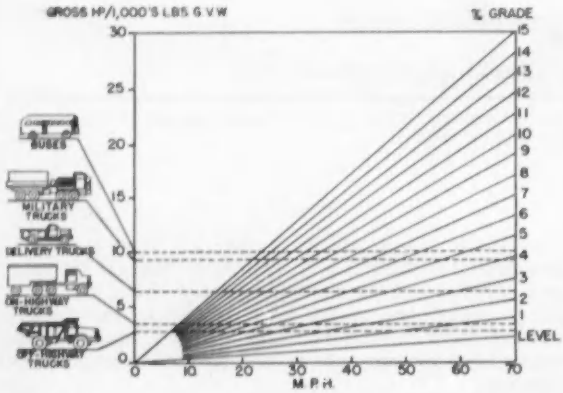


Fig. 2—Performance on grades depends on a vehicle's power-weight ratio. As this chart shows, buses generally give the best performance and off-highway vehicles the lowest of the vehicle groups studied.

Since this class of vehicles is subject to federal and state laws regulating its size and weight, there are many compromises necessary in selecting the type and size of engine, correct transmission ratios, and the gross combined weight of the vehicle. The low power-weight ratio creates the necessity for numerous gear ratios—to handle the numerous grades encountered in cross-country hauling, and to make available maximum horsepower at practically all vehicle speeds.

Most transmissions used in this group consist of four- and five-speed main transmissions which can be extended by two- and three-speed auxiliary gear boxes to provide the required gear ratios. Main transmissions can be also supplemented by two-speed axles to increase the transmission range where required performance permits this arrangement.

The last group of vehicles investigated was off-highway trucks used in logging, oil field, ore and coal hauling, and earthmoving operations. The performance requirements of this type service are very demanding because of the conditions of the terrain over which this class of trucks operates. The haul roads vary from well-maintained to rough undeveloped surfaces, and from level to steep grades. In this type service, the trucks or vehicles operate all year through rainy and freezing weather with changing payloads. Sometimes the operating conditions look almost insurmountable for vehicle activity. But the amazing thing about these units is that they plow their way through these practically impossible situations day after day.

Performance of earthmoving equipment is very important to the operator in the amount of work done. The survey shows that this class of vehicles

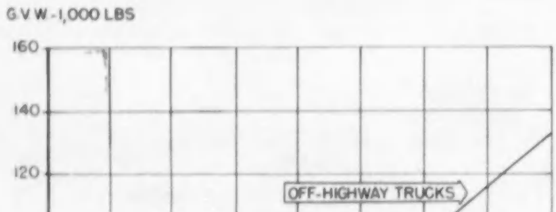


Fig. 3—This chart shows the relationship of gross horsepower and vehicle weight for the various vehicle groups.

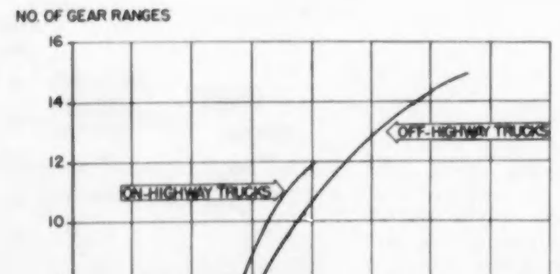


Fig. 4—Investigation showed these to be the relationship of gross horsepower and transmission ranges for various type vehicles.

has a low power-weight ratio and 5 to 15 transmission speed ranges. The work cycle requires the maximum available horsepower over the vehicle's complete speed range.

In summing up the overall performance results of these different classes of vehicles, a general rating chart is shown in Fig. 2. This curve was prepared not for specific situations, but mostly to cover general conditions for determining the approximate requirements to suit performance desired. On this chart the power-weight ratio for each class is plotted to reflect, in a general way, the approximate expected performance from each group.

The relationship of gross horsepower, gross vehicle weight, and transmission speed ranges for the various vehicle classes is shown in Figs. 3 and 4. These curves represent the trend of each factor for each group of vehicles investigated. They are based on average values estimated from specific cases studied.

2. Small Gear Ratio Steps Up Available Power

In addition to the power-weight ratio investigation, a number of gasoline and diesel engines were examined to determine what relationship, if any, exists between the minimum percent of maximum horsepower and the resulting percent of speed variation. This speed variation would represent the percent increments or ratio steps between the transmission gear ranges or shifts. Fig. 5 shows the general trend that was found for both gasoline and diesel engines surveyed. The resulting curves for the two types of engines were selected by averaging all of the specific available engines studied.

As an example, to illustrate the significance of the step ratios between gear ratios, assume that 90% of maximum horsepower of a particular gasoline engine is selected to provide a high available horsepower for a given application. The step ratio would be approximately 1.26. For the same conditions, the diesel engine would be 1.19. This clearly demonstrates that, to operate the engine in the high horsepower range, the steps between gear ratios should be as close as practical to get the maximum available horsepower over the vehicle speed range.

In some cases, where the vehicle has a high power-

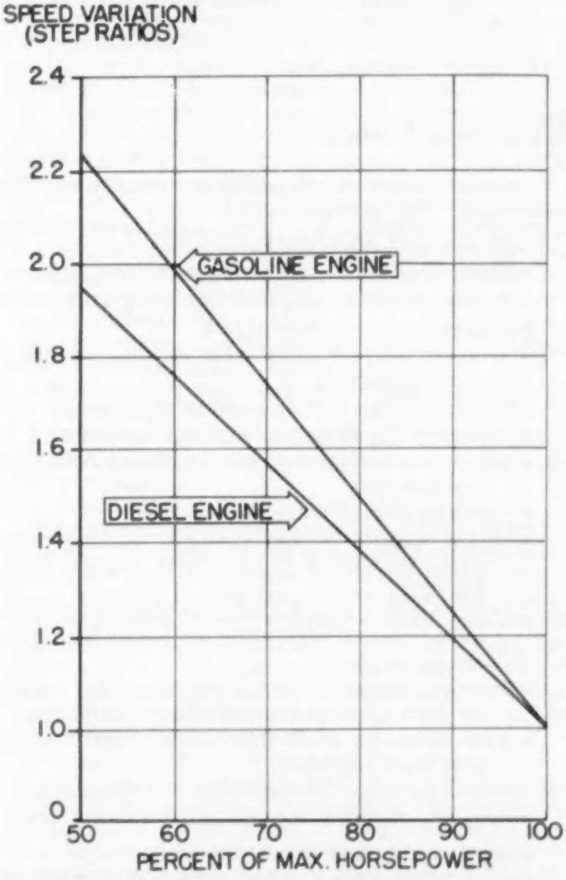


Fig. 5—Plotted here are engine speed variation versus percent of maximum horsepower for gasoline and diesel engines. It's interesting to note that for a given percentage of maximum power, the diesel requires smaller steps between gear shifts than the gasoline engine.

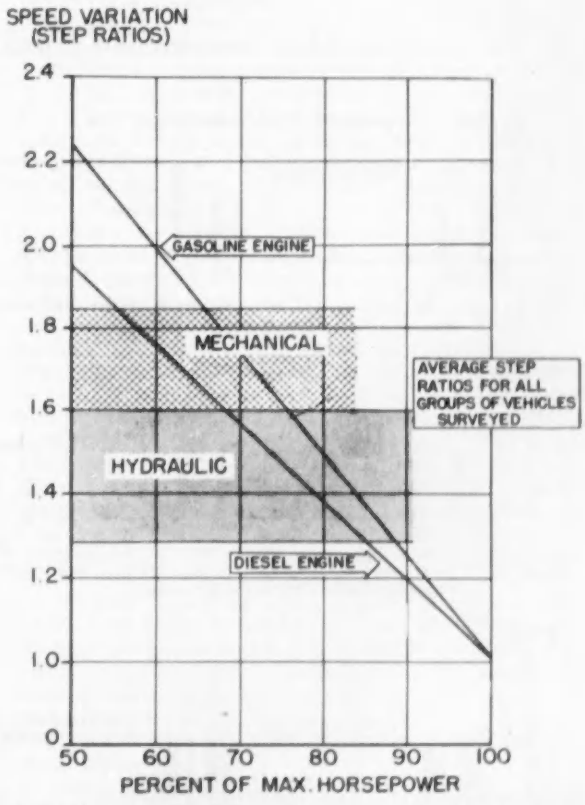


Fig. 6—Hydraulic transmissions make better use of available horsepower than mechanical transmissions because they use more closely spaced gear ratios.

weight ratio, the step ratio values can be increased. This lowers the percent of maximum horsepower and decreases the number of required transmission gear ratios. Although the potential ability of vehicle may not be affected too much by doing this, such practice could cause considerable engine lugging with possible reduction in engine life.

The trend is towards greater utilization of the available horsepower in various groups of vehicles by using closer steps and increased number of transmission gear ratios. That's why it has become more and more difficult for the driver to select the right gear at the right time to take advantage of this disposition of horsepower. As the gear changes increase, the shifting operation becomes so burdensome that it is difficult to keep in the ideal drive ratio, even for an experienced driver. As a result there is a loss in performance and economy. Also, without experienced drivers, the chances for damaged and abused drive line components are very great.

To improve these conditions, automaticity of transmissions has contributed greatly towards providing correct drive ratios under all requirements, operation equally well with all kinds of drivers, and improved average performance and economy.

Another important thing for consideration in the development of transmissions is that they cannot continue to increase their gear ratios and still maintain practical sizes. But by using hydraulic drives in combination with constant mesh planetary gear trains, it is possible to produce small compact transmissions as shown by the present day trend in passenger cars, half-ton pickups to big over-the-road haulers, and off-highway trucks.

Fig. 6 illustrates the trend to better use of the available horsepower by hydraulic transmissions. On this curve the average step ratios for delivery, on-highway, military, off-highway trucks and buses using manually shifted mechanical transmissions are indicated by a band shown in the figure. Also, on this same curve is plotted another band for hydraulic transmissions that are currently applied in the same type of vehicles. It is very interesting to note the definite turn toward the use of smaller step ratios and the consequent increase in the minimum percent of maximum horsepower. This increase permits efficient conversion of the high-power, high-speed portion of the power curve and automaticity insures its availability.

In the development of transmissions today, there appears to be a tendency towards the application of two basic principles in guiding transmission design,

1. Keep maximum power availability at all times (closer spaced gear ratios).
2. Protect engine and vehicle from inexperienced drivers (automaticity).

3. Torque Converter Transmission Brings Operating Economy

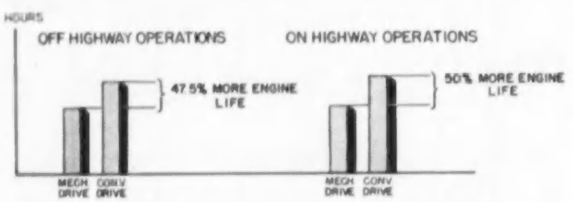


Fig. 7—Engine life goes up with converter drives as compared with mechanical ones.

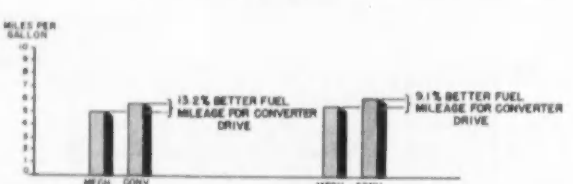


Fig. 8—Data from on-highway operations show that the same type of vehicles give better fuel economy with torque converter type transmissions than with mechanical types.

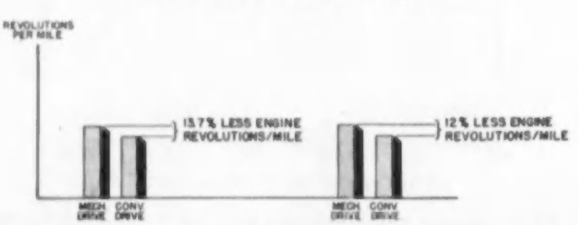


Fig. 9—Here's the reason for longer engine life with converter drives: The engine doesn't make as many revolutions per mile.

Torque converter transmission offers many advantages. For example, it . . .

- Multiplies torque hydraulically.
- Holds the load to the power source at all times.
- Applies power to the load smoothly and firmly.
- Fits the power to the source.
- Protects against shock-load damage to engine and equipment.
- Prevents engine from lugging or stalling.
- Increases life of engine and equipment.
- Adjusts variation between engines in multiple installations.
- Eliminates gear-shift guess.
- Makes possible greater payloads, greater variations in torque output, and higher power factor.
- Quick-shifts under full load at wide open throttle without interruption of power flow from engine to load.
- Provides finger-tip hydraulic gear-shift control on both single and multiple installations.
- Eliminates double-clutch pedal pumping and gear clash grind.
- Increases service availability of equipment.
- Reduces operator fatigue and promotes safety.

Figs. 7 and 8 compare results of engine performance for mechanical and hydraulic torque converter drives. Referring to Fig. 7, the engine life is compared between off- and on-highway operations. The converter drives had approximately 47.5% more en-

gine life on off-highway operation and 50% in on-highway operation than their respective mechanical drives.

Fig. 8 indicates the fuel economy results from on-highway operation when using torque converters in the same type of equipment commonly using mechanical transmissions. The converter drives had 9.1 to 13.2% better fuel mileage than the mechanical drives.

Figs. 9 and 10 demonstrate clearly why more engine life and better fuel economy were possible with the converter drives. In Fig. 9, the results between the mechanical and converter drives showed the hydraulic drives had 12 to 13.7% less engine revolutions per mile than the mechanical drives. In addition to having less engine revolutions per mile, the converter unit provided a much better power factor where load variation was quite high.

Fig. 10 illustrates what happens where the terrain requires a continual adjustment of power to the varying load conditions. This particular cross-country run was a long steep grade on a regular haul over which both the mechanical and converter equipped tractor-trailers were operating. To negotiate the hill and maintain the best possible speed, the mechanical unit required 19 shifts as compared to one shift by the converter truck. The amazing thing about this phase of the operation was the final resulting speed of each truck at the top of the grade.

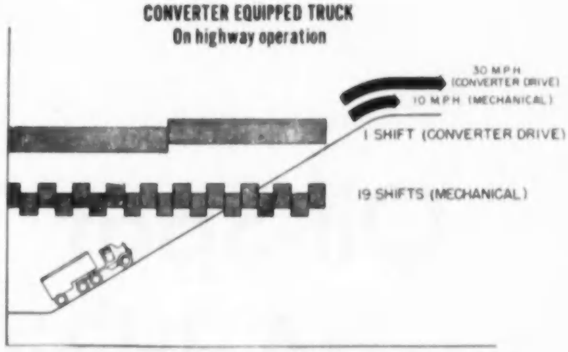


Fig. 10—To negotiate one particular grade, the driver of the mechanical-drive truck had to shift 19 times; the driver of the torque converter-equipped truck, once. And the former truck was moving at 10 mph at the top of the grade as against 30 mph for the latter.

The high performance of this country's military vehicles is the result of new improved torque converter transmission designs in production and under development. The controlling thought in the development of these transmissions is getting the smallest practicable power package of engine, cooling system, transmission, and steering-braking systems. For track-laying vehicles, this was accomplished by utilizing the torque converter advantages and including in the transmission unit the steering and braking. The same ideas were also used in the wheeled vehicles. Without sacrifice of military characteristics, the vehicle power-weight ratios were improved. The transmission design objectives may be summed up as follows:

- Maximum power availability and performance coverage.
- Minimum size and weight.
- Highest vehicle maneuverability and ease of operation.
- Simplified installation and adjustment.

Paralleling the use of hydraulic torque converters in military vehicles is the application of the same basic type of transmissions in off-highway vehicles. These vehicles include most of those found in iron range operation, in the logging business, in the oil field industry, in coal hauling activity, and in earthmoving work. The adverse operating conditions under which these vehicles work virtually force the selection of hydraulic transmissions as one of the chief components of the drive train.

An example of this pressure is the Arabian American Oil Co., which uses off-highway heavy-duty trucks in many of its operations in far-off Saudi, Arabia. This company has re-examined the ability of its equipment to handle the greater distances between area of supplies and operations, and the rugged terrain, resulting from the increased scope of the company's operations. Many of its trucks weigh up to 200,000 lb, gross combined weight, and have mechanical four-speed main transmissions with three-speed auxiliaries and operate in many types of terrain and under diverse operating conditions. Until the company's scope of activity was increased, these vehicles were handling the operations successfully.

Based on these changes, new objectives were adopted to simplify operation and improve efficiency of power train. The standard clutch and mechanical transmission were replaced with torque converter and three-speed semi-automatic hydraulic transmission. This increased tractive effort, mobility, and average cross-country speed.

Preliminary tests showed that over terrain where "gear splitting" was required to keep the standard truck moving at a satisfactory speed, only an experienced driver could equal the speed of the hydraulic drive. Furthermore, personnel who had never before driven similar heavy equipment were able to operate the new truck after only a few moments of coaching. They could handle a heavy loaded trailer negotiating sand dunes and other rugged terrain with the proficiency of an experienced driver.

More and more mine operators are finding it worthwhile to convert trucks from mechanical to hydraulic drive. For example, the Sunnyhill Coal Co., early in 1953, replaced 30 direct drive, 20- and 30-ton trucks with ten 55-ton trucks equipped with hydraulic torque converter drives at their New Lexington, O. mine. Soon after the beginning of their use, operating costs dropped 18.6¢ per ton, maintenance costs were cut 13.1¢ per ton, and the trucks now haul 32.6 more tons per truck hour.

In addition, inclement weather worries have almost disappeared for this operator. That's because his torque converter and three-speed semi-automatic hydraulic transmission equipped trucks can operate on roads where direct drive trucks previously bogged down. Furthermore, this operator's drivers are now more alert behind the wheel and less fatigued after a day's work. The mine's equipment supervisor asserts, "The men almost fight to drive these rigs."

(Paper on which this abridgment is based is available in full in multilith form from SAE Special Publications Department. Price: 35¢ to members, 60¢ to nonmembers.)

Oil-Spot Test Reveals Additive Depletion

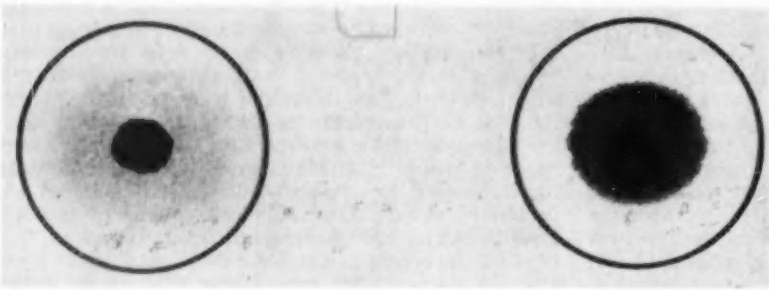


Fig. 1—Poor dispersancy is typified by sharp, well-defined pattern shown at left. Pattern of good dispersancy features fuzziness and laciness, as shown at right

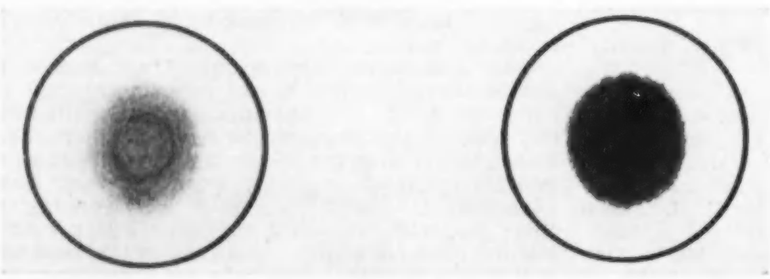


Fig. 2—Typical patterns of oils with good dispersancy. Spot on left has small amount of insolubles; that on right contains large amount

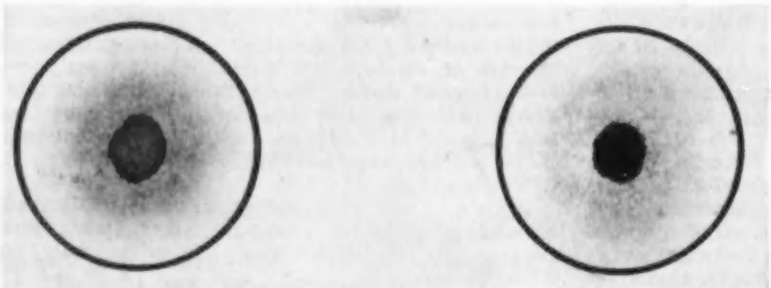


Fig. 3—Patterns of poor dispersancy. Spot on left has low insolubles, while one on right is heavily contaminated. Both feature small size and sharp outline

and Oil Contamination

V. A. Gates, R. F. Bergstrom, T. S. Hodgson, and L. A. Wendt,
Shell Oil Co.

Based on paper, "'On the Spot' Testing of Used Lubricating Oils," and the discussion that followed its presentation. Presented at SAE National West Coast Meeting, Los Angeles, Aug. 17, 1954.

THE oil-spot test is a modified form of paper chromatography. It is a simple, quick, and inexpensive technique for checking the effectiveness of the oil during use. The operator himself can perform it in the field, to help him:

- Decide when he should drain the oil.
- Spot certain types of engine malfunctioning before mechanical failure occurs.

(This technique will not provide all possible information, but it does supply that desired for routine control. Where special problems exist, a more extensive laboratory analysis is made.)

Need for Oil Drain

Before deciding if the engine oil should be drained, the operator needs to know:

- How effective are the additives remaining in the oil (that is, if it contained additives to start with)?
- How badly contaminated is the oil?

Additive Effectiveness

The spot test can show how well the following kinds of additives are holding up:

- Dispersants (also called detergents—which help protect the engine from deposits).
- Alkaline additives (which help protect the engine from wear).

The dispersancy level can readily be estimated from the pattern developed when a drop of used oil is applied to the proper kind of paper (a soft, neutral, analytical filter paper).

If the dispersancy level is low (as shown at the left in Fig. 1), the spot—or chromatogram—is small, with a sharp, well-defined outline. The burden is deposited *on* the paper essentially under the original spot. The engine using this oil isn't getting much protection from deposits. It's time for an oil change.

Good oil dispersancy produces a fuzzy, almost lacey pattern (as shown at the right in Fig. 1). These contaminants have been carried well *into* the paper. How much this burden spreads over the paper tells how effectively the dispersant is preventing contaminants from depositing on engine surfaces. The greater the spread the greater the dispersancy—and the greater the protection.

Most modern lubricating oils contain alkaline materials to neutralize acids of combustion (and thus minimize corrosive cylinder and ring wear). Just as with dispersants, they are consumed as the oil is used.

A special color indicator approximates alkalinity level. It may be applied to a fresh spot used only for color indication or after other readings have been made.

If the indicator turns blue (or blue-green) directly under or next to the spot, the oil is alkaline. If it becomes red or pink, the oil is acidic. If the indicator doesn't change color, the oil is neutral.

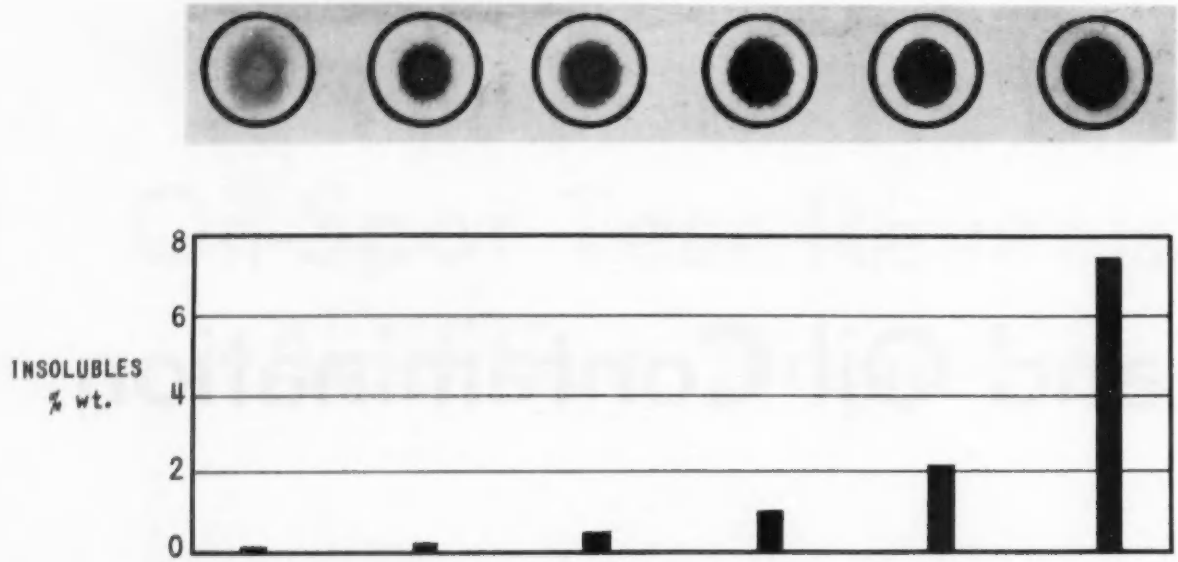


Fig. 4—Series of used oil spots from diesel engines. Density of color is indicative of amount of soot contamination, and may be judged quite closely. Jet black spot on right is typical of excessive soot contamination

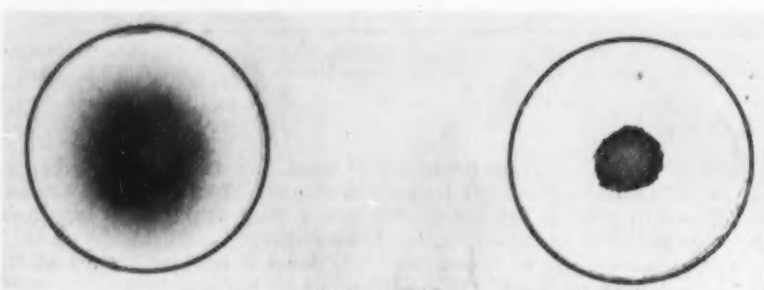


Fig. 5—Moisture contamination exerts definite effect on pattern. Typical is narrow, well-defined, dark ring with lighter center area, as shown at right. Antifreeze such as glycol results in spot similar to one on right, but may exhibit more uniform density. For comparison, pattern for dry oil is shown at left

Neutrality in a noncompounded oil has no significance, but when an alkaline compounded oil becomes neutral, it is no longer able to check corrosive wear. A crankcase drain is then in order.

The oil-spot test can't show oxidation inhibitor depletion, but this isn't a serious defect. Elaborate laboratory tests don't either.

Oil Contamination

An engine oil may contain both soluble and insoluble contaminants. Among the latter, soot and coolant are revealed quite simply by the spot test.

Fig. 2 shows the patterns for two oils of good dispersancy but having quite different soot contents. Both have the usual fuzzy, lacey pattern of dispersant oils. Even with a heavy soot load, such oils spread the insolubles over a wide area.

Fig. 3 shows characteristic patterns for oils of poor dispersancy, having low and high soot levels. Even the spot for the mildly contaminated oil is small, with a sharp outline. This oil wasn't able to disperse properly even a small amount of solids.

Fig. 4 shows that spot density gives a good indication of the amount of soot contamination in diesel engines. This figure relates the density of a series of spots to weight of insolubles. These spots developed to about the same size, for the oils all had sufficient dispersancy to carry soot loads well into the paper. (The jet black spot on the right shows that excessive soot load can actually obscure pattern development. The need for an immediate drain of this oil is obvious.)

Such a correlation is hard to make for gasoline engines because inorganic salts, being heavier than soot, markedly increase the weight of insolubles. Only the fact that the oil is contaminated is readily detected.

Oil containing moisture develops a well-defined dark and narrow ring with a lighter center area (as the right-hand spot in Fig. 5 shows). Glycol antifreeze gives a similar pattern, but with a more uniform density. (Coolant contamination—whether from water or antifreeze—can modify a dispersant oil to one of little or no dispersancy.)

Fuel can also contaminate the oil, thereby decreasing oil viscosity. This change in viscosity cannot be measured by the spot test, but there are simple viscosity comparators suitable for making quick determinations in the field. (Viscosity measurement is also useful for evaluating the viscosity increases common for gas engine oils.)

Metallic contaminants—whether as tiny particles or in solution—can be neither identified nor measured by the spot test. Spectrographic or chemical analyses would be required for the few cases where this is necessary. Generally, a method merely of detecting them would be sufficient. This can be done fairly reliably for the metallic particles by inspecting oil filter element surfaces.

Engine Malfunctioning

The oil-spot test will often indicate that an engine is in trouble before it actually breaks down. This capacity to foretell the future is due to its ability to show:

1. The presence of coolant in the oil.
2. How the soot in the oil varies over a period of time, if the tests are run at regular, frequent intervals.

If antifreeze contamination is found, there must be a leak in the cooling system.

If water is the coolant and water is found in the oil, it may be coming from either a cooling system leak or condensed blowby. During low-temperature

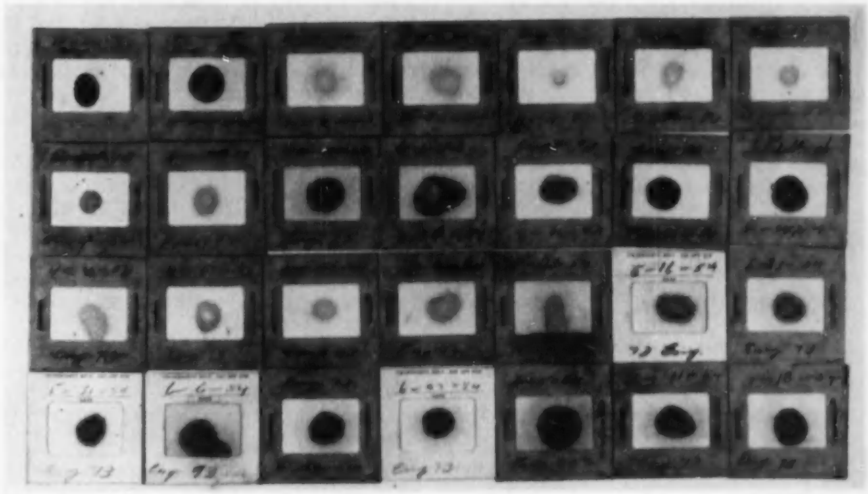


Fig. 6—Series of oil spots taken for Sterling 650-hp engine using SAE 30 oil of DG service classification. DS oil was used for make-up

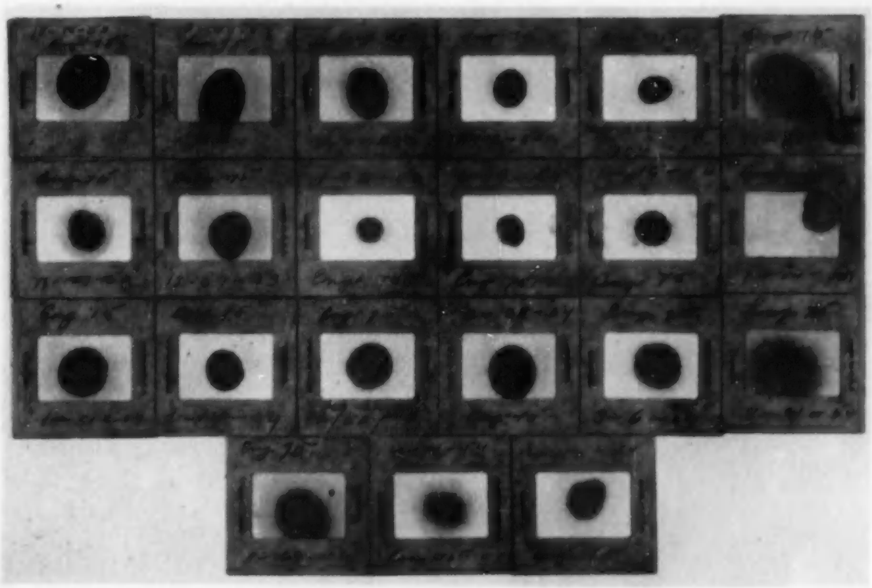


Fig. 7—Spot test results for engine plagued with temperature control problems

operation, the latter may well be the explanation (Here, the water indication will be slight.)

In any case, an oil change and a thorough investigation are needed, for coolant contamination can drastically reduce oil dispersancy.

A gradual increase in soot each time a spot test is made generally indicates normal operation. A sudden loading of soot means something is wrong—and the engine should be inspected as quickly as possible.

In Practice

How does the oil-spot test work out in practice? Here are a few samples, taken from the files of an operator who has already made the test standard procedure for his logging operations.

Fig. 6 shows a series of oil spots taken between Oct. 18, 1953, and July 18, 1954. The Sterling 650-hp engine used an SAE 30 oil of the DG service classification. DS oil was used for make-up.

The second test spot shows the oil heavily burdened with soot. As a result, the oil filter was changed. The new filter cleaned the engine's 85 gal of oil in a week.

The next six to eight tests show a gradual progression of soot loading. Then, during the week of February 21–28 a sharp, black ring appeared, pointing to excessive water contamination. There was also a sudden loading of soot. Both are indications of mechanical trouble.

Armed with this knowledge, mechanics tore down the engine. They found a broken head, which they replaced.

The next four samples show a tendency to clear the oil, but apparently the filter element was loaded, so it was changed. Tests during the next 14 weeks show normal progressive loadings of soot.

A series of oil spots for a similar engine are shown in Fig. 7. This unit was plagued by improper temperature control, which is indicated by erratic spot test results. Eventually, mechanics found a negative head on the pump intake, which had permitted suction of air into the system. In March this condition was corrected, and the succeeding five samples show a very good progression.

Fig. 8 shows oil spots for an International crawler tractor (TD18) after it had come back from a shop teardown, including a ring change. The overhaul had been ordered because previous tests had shown the oil to be high in soot content.

The first spot—taken 32 hr of operation after the overhaul—shows the soot accumulation was again high. It continued to get worse. Field men were advised to check the air, fuel, temperature, and the possibility of stuck rings. After two attempts, they reported "no trouble."

Determined to find the cause of the soot accumulation, management requested further inspections. Finally, mechanics removed all air filter screens. They found the screens plugged inside with last summer's dust. As soon as the screens were cleaned the soot loading of the oil stopped.

Without the insistent warning signal of the spot test, the operator admits, they would have gone blithely on using the engine—until real trouble hit.

(Paper on which this abridgement is based is available in full in multilith form from SAE Special Publications Department. Price: 35¢ to members, 60¢ to nonmembers.)

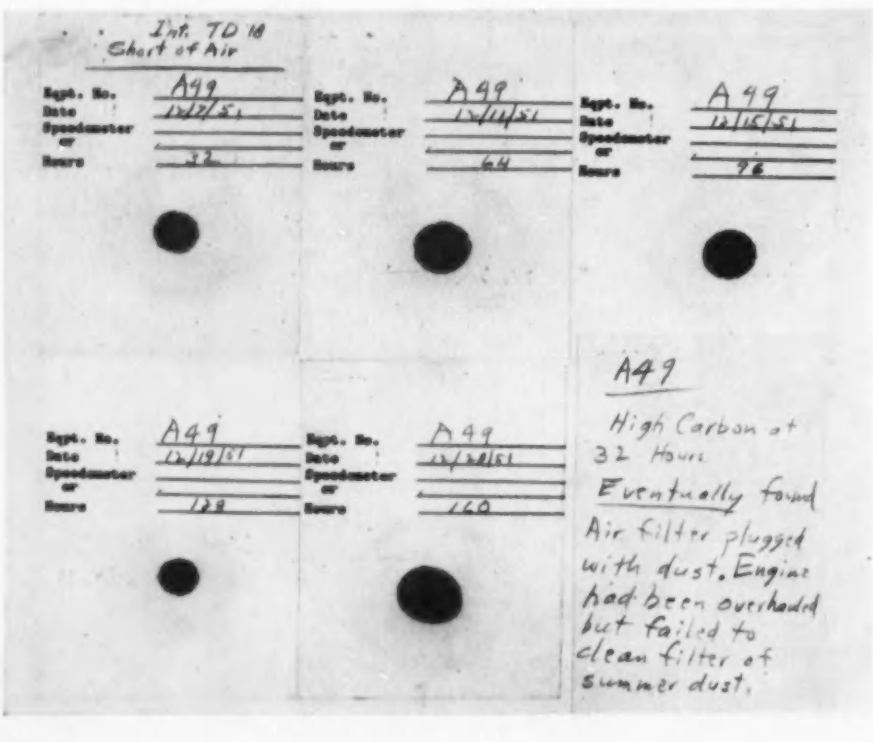


Fig. 8—Series of spots taken for International crawler tractor that was experiencing mechanical difficulties

Air Springs Make Good In Diverse Applications

Roy W. Brown, Firestone Tire & Rubber Co.

Based on paper, "Air and Heavy Vehicle Suspensions," presented at SAE Golden Anniversary Annual Meeting, Detroit, Jan. 14, 1955.

LIGHT-weight, low-cost, highly elastic, easily controlled air is an outstanding elastic medium for spring suspensions. This conclusion is drawn from experience gained with air springs in such diversified applications as industrial trailers, railcars, buses, passenger cars, and heavy military vehicles.

With air springs it is quite easy to provide sufficient damping, thus overcoming the limiting factor on the fast, over-the-road vehicles being used today.

Disconcertingly enough, under some operating conditions, the payload may suffer more damage with improperly damped springs than without any springs. This damage comes from the force of the vibration and the number of times it is repeated.

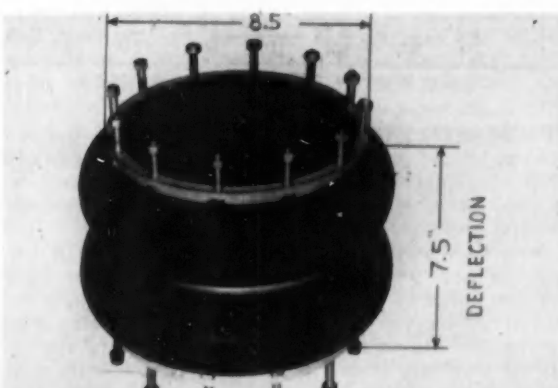
When air is the suspension medium, controlling the back and forth airflow from the bellows to its reservoir provides all the damping needed.

A typical air spring bellows is shown below, along with a sketch of an air spring suspension.

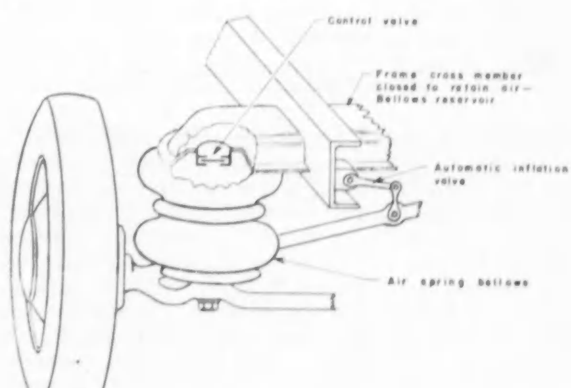
The application of the air spring suspension to an industrial trailer is depicted on the next page, plus two graphs that point up some of the important advantages of the air spring.

(Paper on which this abridgment is based is available in full in multilith form from SAE Special Publications Department. Price: 35¢ to members, 60¢ to nonmembers.)

Turn page for more on air springs

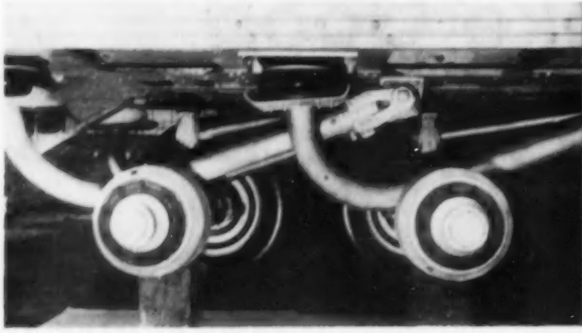


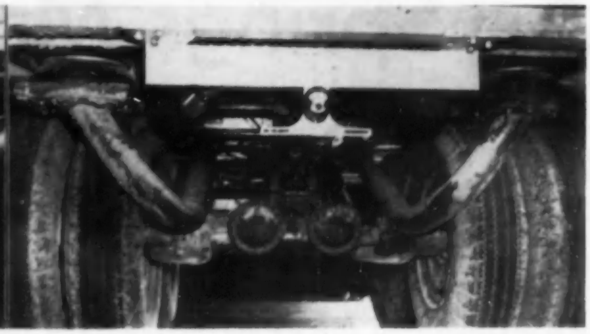
TYPICAL AIR SPRING bellows for heavy vehicle suspensions. Made of reinforced nylon tire cord, it will carry 7000 lb, weighs only 5 lb. Air springs have been made for 25,000-lb load, may be made much larger, if desired.



ESSENTIALS OF AIR SPRING vehicle suspension. Different arrangements are required for various axle and wheel positioning devices. Bellows is connected to reservoir through control valve. This provides shock absorber or antiroll effect.

More On Air Springs for Trucks

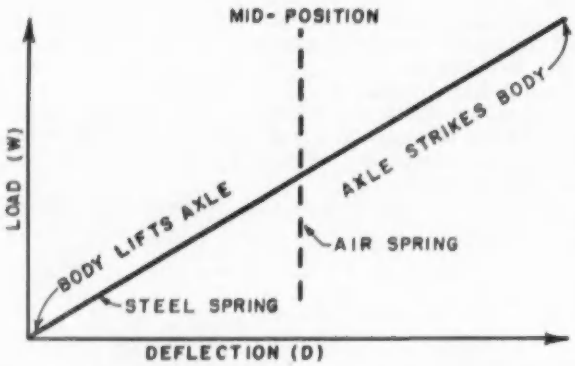


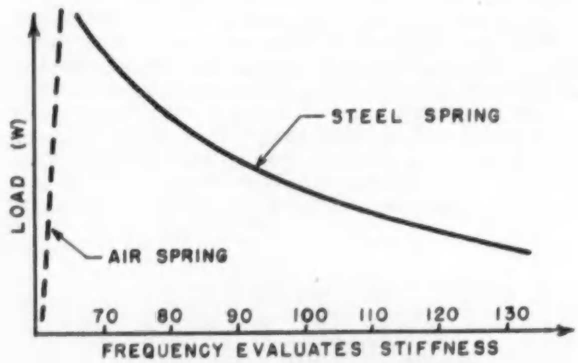


SHOWN HERE is a 2-axle air spring suspension on a heavy over-the-road trailer with the springs installed high and wide apart to reduce body roll when cornering. Above is a side view, with the near side dual wheels removed. At the right is a rear view of the same installation.

The air springs are attached to the rear end of a tube supporting the axle and attached at the front end to the body structure. The upper end of the air spring supports the body at its full width and only a few inches below the floor level. This, with a V-shaped lateral axle positioning member pivoted high above the axle center, virtually eliminates roll in cornering, with freedom from steering and other handling interferences. The axle tubes also serve as reservoirs for the air springs.

Pneumatic load equalization between the tandem axles and the roll center well above the axle promise passenger-car suspension performance for heavy, high-speed units.





THE ABOVE GRAPH shows that steel springs deflect a constantly increasing amount as load is added. Thus, when steel spring suspensions are used, they are oftentimes too stiff for small loads, if they have sufficient capacity to carry the maximum vehicle load. The inevitable result is excessive damage to the material being transported. In fact, the damage caused by high-frequency vibrations transmitted by the stiff steel springs of partially loaded freight cars and large over-the-road vehicles motivates continuous and extensive investigation. As a result, it has been estimated as a multimillion dollar per year liability against the transportation industry in the United States. The graph also shows that this problem does not exist with air springs, for they maintain a constant deflection irrespective of load variations when automatically inflated through a valve connected to the body and to the axle.

IT HAS BEEN SHOWN that deflection of the suspension as loaded determines the mathematical relationship of displacement, velocity, acceleration, and frequency at which the load will oscillate when deflected from its static position and released. Suspension stiffness may be evaluated in terms of frequency for any type of suspension on a common basis for very large as well as very small loads. The graph above shows the stiffness of a conventional steel spring and its equivalent air spring. Note the air spring stiffness does not increase appreciably with small loads, while the steel spring becomes very much stiffer, transmitting much more of the road shock, with increased damage to the material being transported. A small air valve mounted on the body and connected to the axle will keep the largest air spring inflated to its optimum midposition. Thus, constant springing for heavy-vehicle variable loads has been attained.

How Piston Rings Wear Out

C. E. Watson, F. J. Hanly, R. W. Burchell,
California Research Corp.

Based on paper "Abrasive Wear of Piston Rings," presented at SAE Golden Anniversary Annual Meeting, Detroit, Jan. 11, 1955.

ABRASIVE particles which slip into the combustion chamber cause wear of piston rings. The amount of wear depends upon the size and properties of the abrasive and the method by which it gets in.

Abrasive entering through air induction system

When an abrasive particle gets into an engine cylinder through the air induction system during the intake stroke, it probably will remain air-borne because of the extreme turbulence. It will, in all likelihood, leave the combustion chamber during the next exhaust stroke. Most air-borne abrasives do, particularly if they are minute particles.

But, if the particle hits the cylinder wall oil film during the intake or power stroke, it will probably cause wear of the piston ring and cylinder wall during the next upstroke of the piston. How much depends on the size of the particle and its physical properties. The influence of size and physical properties of various materials upon top compression ring wear is shown in Fig. 1.

If the abrasive is soft, it disintegrates as it rubs against the metal. Most abrasion occurs immediately and becomes less as the particle is worn smoother and smaller. Road dust and magnesium oxides fall in this classification. Wear is confined to the top compression ring. The abrasive wear debris consisting of particles no larger than 5 microns in diameter, is washed into the crankcase oil.

If the abrasive is hard, its size does not change appreciably while it is in the engine. Diamond, aluminum oxide, chromium oxide, and iron oxide fall into this classification. These abrasives cause high wear of all piston rings and, after entering the crankcase oil, continue to cause high wear rates. They must be removed from the oil by filtration or oil change. Fortunately very few natural air-borne dusts are that hard.

Abrasive entering through oil system

If an abrasive particle enters the crankcase oil, it probably will cause piston wear. Unlike an air-borne particle, wear is not immediate, and it depends on the particle entering a zone where it can cause wear. The greater the number of particles and the greater the ratio of the amount of oil in the critical wear zones to the crankcase oil volume, the greater the probability of wear.

When a soft abrasive is in the oil, the particle is worn smaller until it can no longer cause wear. Thus wear rate decreases constantly as the number of wear-causing particles decrease.

Large and hard particles cause a comparatively constant wear rate because the number of particles does not change.

Small amounts of soft abrasives cause, first of all, high wear of the oil control ring. There is comparatively no wear of the compression rings. More abrasives will cause excessive wear of the lowest

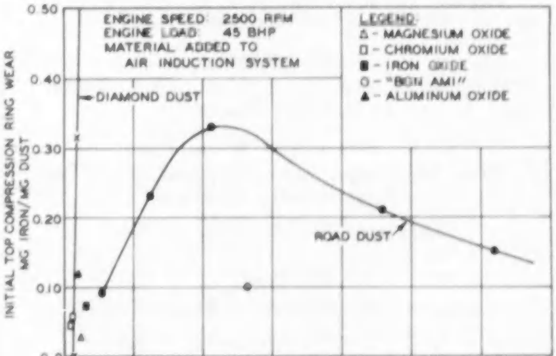


Fig. 1—The influence of size and physical properties of various abrasive materials on top compression ring wear

compression ring, then proceed upward on the piston to the remaining compression rings as the lower rings lose tension and are less subject to wear.

About ten times as much wear is caused by abrasives in crankcase oil than by equivalent amounts of air-borne abrasives.

Pistons are hydrodynamically lubricated

The fact that piston wear drops sharply when abrasive particles reach a very small size lends support to the belief that piston rings operate under hydrodynamic lubrication instead of boundary lubrication.

Evidently the lubricant film separating the piston ring from the cylinder wall is thicker than the particles, thereby preventing wear. From Fig. 1, an extrapolation of the road dust curve finds that no abrasive wear will occur with particles less than one micron (0.000039 in.) diameter. Evidently the lubricant film is more than one micron and the particles are too small to bridge the distance and cause wear.

Engine speed appears to have essentially no affect on wear rate. At low engine loads the rate of increase of ring wear is gradual; above 22.5 bhp, the increase is considerably greater. Lubricating oil viscosity appears to affect piston ring wear only slightly in the SAE 10-50 grade range.

(Paper on which this abridgment is based is available in full in multilith form from SAE Special Publications Department. Price: 35¢ to members, 60¢ to nonmembers.)

THE method used for measuring piston ring wear in this article was the radioactive piston ring technique described by P. L. Pinotti, D. E. Hull, and E. J. McLaughlin in SAE Quarterly Transactions, Oct. 1949, Vol. 3, p. 634-638.

Wear is measured by determining with a Geiger counter the amount of radioactive metal worn off the piston rings and present in the lubricating oil. Method is both accurate and fast, and does not require breaking down the engine after each test.

Other papers on the same or related subjects are:

J. M. Chandler,
"Radioactive Cobalt Shows Ring Rotation"
SAE Journal, Dec. 1953, p. 112

H. R. Jackson, F. C. Burk, L. J. Test, and A. T. Colwell,
"Some Phenomena of Engine Wear as Revealed by the Radioactive Tracer Technique"
SAE Journal, Feb. 1952, p. 24

F. W. Kavanagh,
"Engine Wear-Comparison of Radioactive Wear and Field Measurements"

H. R. Jackson,
"Laboratory and Field Wear Tests Using Radioactive Tracers"

C. C. Moore and W. L. Kent,
"Wear Measurements by Physical, Chemical or Radioactivity Methods"
SAE Journal, Dec. 1952, p. 44

W. Reid,
"Industrial Application of Radioisotopes"
SAE Journal, May 1950, p. 43

Based on discussion . . .

C. M. Heinen,
Chrysler Corp.

The conclusion that the crankcase oil viscosity is not a factor in engine wear appears premature when it is considered that the temperature at the top ring is certainly not representative of that obtained elsewhere in the engine or even the rest of the ring line-up. Probably a more accurate conclusion would be that viscosity of crankcase oil does not affect the abrasive wear of the top ring.

R. E. Kennemer,
Caterpillar Tractor Co.

With soft abrasives, wear is not limited to the top compression rings in a Diesel engine. Extrapolation of wear curves relating wear to dust particle size cannot be expected to provide accurate information, since each plotted point for a particle size is only an arbitrary point selected to represent the many particle sizes contained in each sample.

The lubrication between a piston ring and cylinder is partially hydrodynamic and partially boundary. Probably there is hydrodynamic lubrication of a ring during the time when the relative velocity between the ring and cylinder is high, and boundary lubrication at the ends of each stroke. In view of the extremely low rates of wear of rings and cylinders which may occur under clean conditions with low sulfur fuel, it seems apparent that the rings must be well lubricated most of the time, but it also seems unlikely that rings are hydrodynamically lubricated at all times.

M. J. Caserio,
AC Spark Plug Div., General Motors Corp.

This paper points up the need for adequate air and oil filters. It is not necessarily the hardness of the particle which controls its resistance to disintegration by the piston rings. Some materials have good cleavage planes which may allow easier destruction. And some natural dusts have properties different from pure abrasive crystals due to large amounts of colloidal materials mixed with them in their natural state. Each dust particle is coated with a film of the colloidal materials. This helps keep the dust particles relatively uniformly dispersed throughout its carrying medium, while the pure abrasive particles have a greater tendency to adhere to one another.

New Facts For Your File On

Controlling Aircraft Manufacturing Costs

J. M. Isaac, Douglas Aircraft Co., Inc.

Based on secretary's report of panel discussion on "Control of Manufacturing Costs," held as part of the SAE Aircraft Production Forum, Los Angeles, Oct. 6, 1954

TO REDUCE and keep manufacturing costs low, the aircraft manufacturer must have a well-planned and flexible cost control program. It must be followed-up during scheduling, fabrication, and assembly; and it must be constantly revised to meet changing requirements.

During basic programming and scheduling . . .

Early in the planning stage the requirements of the engineering, planning, tooling, and manufacturing phases of aircraft manufacturing must be coordinated and clearly understood. A cost control procedure must be established. But first, the following data are needed to help management make logical decisions:

1. A general description of the project.
2. A statement of assumptions on which labor loads are based; such as, the total number of airplanes contracted for, the peak rate, the number of hours in the work week, the labor shift distribution, current load forecast, and capital investment in the facilities.
3. A tooling policy statement.
4. A production breakdown of tools.
5. Tooling and manufacturing estimates and labor loads.
6. Detail schedules and complete flow charts.
7. Area requirements.

The Experts:

This article is based on a panel discussion by the following experts:

Panel Leaders

Morrie Harper,
Douglas Aircraft Co., Inc.

A. F. Kitchin,
Rohr Aircraft Corp.

Panel Secretary

J. M. Isaac
Douglas Aircraft Co., Inc.

Panel Members

M. A. O'Connor,
Douglas Aircraft Co., Inc.

J. F. Knapp,
Lockheed Aircraft Corp.

H. E. Herdrich,
Northrop Aircraft, Inc.

J. W. Pocock,
Booz, Allen, and Hamilton, Management Consultants

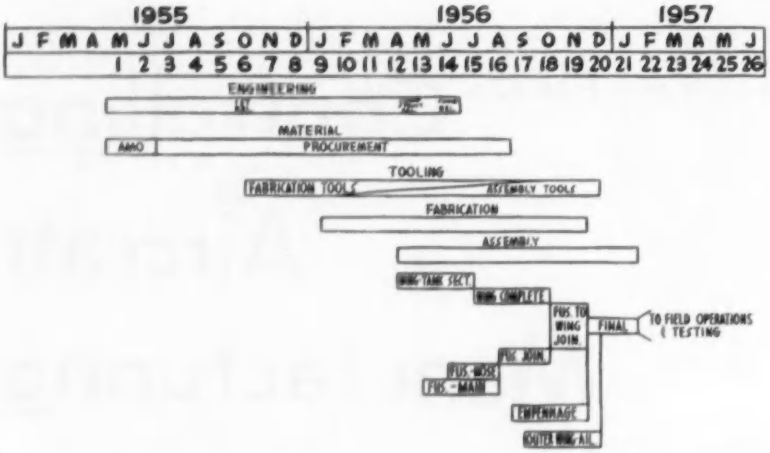


Fig. 1—This sample master schedule chart shows the four basic activities in the manufacture of aircraft: engineering, material procurement, tooling, and manufacturing. Starting and completing dates for each activity are estimated from past experience

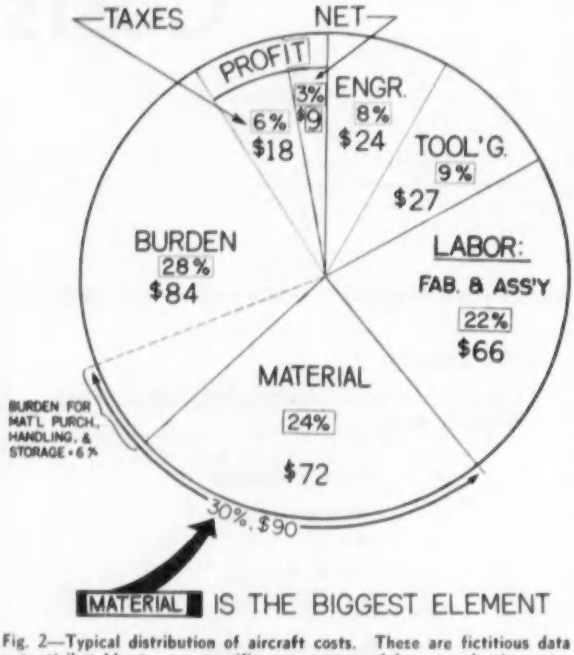


Fig. 2—Typical distribution of aircraft costs. These are fictitious data not attributable to any specific company, model, or production rate. Dollars are in millions and distribution is based on $300,000,000 sales

With these data on hand a basic program and schedule can be set up. A master schedule, similar to the one in Fig. 1, can be estimated from past experience.

The tooling and manufacturing estimates are made from hours-per-pound comparisons with previous similar models. The schedules department uses these data to establish flow time for the total assembly, and set job schedules for individual assemblies. From this, detailed labor loads can be predicted.

A typical cost distribution is shown in Fig. 2. The chart shows that material costs about 24% of the total airplane price. The cost of purchasing, handling, and storing material adds another 6%. With so much money tied up in materials, it is important that the total time which materials are on hand (that is, the in-plant flow time) be scheduled as short as possible.

Tight scheduling will reduce material flow time, and cut down the amount of work actually in-process. This will:

1. Release money that is tied up or borrowed for materials.

2. Reduce taxes. (The Government taxes 3% of the cost of those materials not actually in-process.)

3. Reduce the cost of storage and production floor space. This often costs between $0.60 and $1.20 per sq ft per year.

4. Release material to be spread around the industry during shortages.

In addition to the above savings, a well-planned routing system and plant layout, on a "least handled is best handled" basis, can save considerable money by cutting waste due to damage, and reducing paper work.

Another way of controlling costs during the planning stage is choosing an economical production breakdown during the preliminary design stages.

A great part of the flow time necessary to manufacture an airplane is the direct labor time. (Over 500,000 hr are not unusual for a new airplane weighing about 25,000 lb.) Therefore, to reduce flow time, the production breakdown must be devised to "load" the most possible labor upon a plane during its manufacturing cycle.

This can be done by subassembling as much as possible outside of the aircraft frame, and joining the subassemblies to the airframe in large sections.

Two different production breakdown ideas are shown in Fig. 3. The manufacturer desires accessi-

bility and maximum man-loading. Although his design weighs more—due to more production breaks which must be joined by heavy bolts—it is open during assembly and more workers can work on it at the same time. On the other hand, the engineer designs for minimum weight, even if this results in cramped, inconvenient working spaces during assembly. So, a compromise must be made to approach both goals: less weight and less flow time. Here are some specific ideas for accomplishing this:

1. Use manufactured production joints without jig requirements.

2. Join breaks by squeezing the fastenings rather than by beating, thus minimizing metal flow and maintaining fit.

3. Design break points with the greatest possible tolerances.

4. Design and plan installation to go over frames and webs instead of through them. If this isn't possible provide large enough cutouts to pass all necessary components of the assembly being installed.

5. Plan assembly line jobs at the same multiple of the overall production interval. That is, if the overall production interval is 16 hr, plan 8- or 4-hr jobs.

6. Plan and design assembly tools with maximum accessibility. For example, use single plane jig structures, not box jigs.

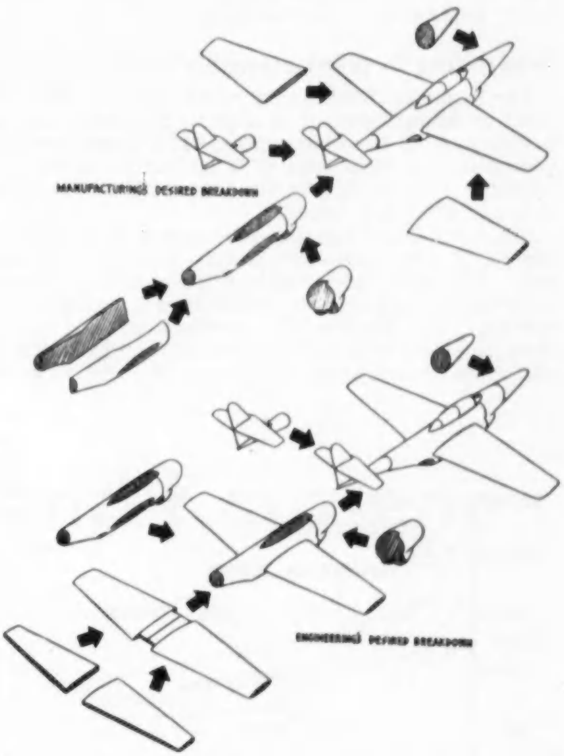


Fig. 3—The manufacturing department wants a production breakdown that permits maximum accessibility and maximum man-loading. The engineer wants the plane to be assembled with minimum weight

Some basic principles . . .

Even if the airplane has been designed for the lowest possible costs during manufacturing, and the operation has been scheduled for the lowest possible flow-time and maximum man-loading, there will still be waste unless the in-plant fabrication and assembly costs are controlled.

Here are several basic precepts for keeping these costs low:

1. Assign responsibility for costs clearly and logically to one person for each operation.

2. Measure the costs against standards that are high but attainable.

3. Supply accurate, simple, and complete data promptly to the persons responsible for controlling costs.

4. Follow through on corrective action in all phases of the operation.

Controlling in-plant fabrication costs . . .

Fabrication cost controls are established by considering past experience, the contract price, standard hours, and shop conditions. To keep control, records are necessary. Fig. 4 is an example of a fabrication hours control chart.

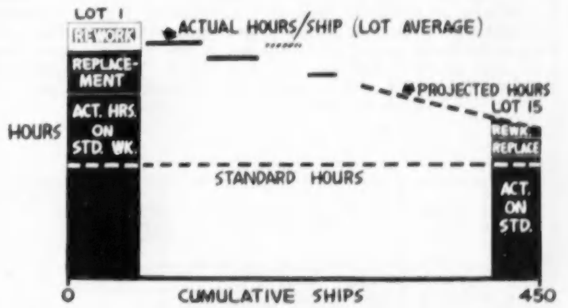


Fig. 4—This fabrication hours control chart shows that allowances may be made for some rework and replacement hours, but they must diminish as the project moves along. Something caused lot 4 (above) to go wrong but prompt corrective action brought the next lot into line

Except for rework and nonstandard work, time is picked up for all standard work done in the department for a given week and pooled. It is prorated to the lots on the basis of the ratio of standard hours completed for a given lot to total standard hours completed in the department for the week. In this example, time is separated into rework, replacement, and standard. (Standard is the first time through on work that is properly planned, tooled, and routed.)

To keep control action most effective, the group should be kept small and under one leader. The

leader should know what caused any variance from target and correct it immediately.

Controlling in-plant assembly costs . . .

The leadman, foreman, or supervisor of a department or operation must be able to determine why a deviation from the plan occurs, when corrective action will take hold, and to what extent it will be effective. To do this he must have control reports that are brief and timely.

Fig. 5 is a typical on-the-job control chart usually posted at the leadman's station on the assembly line. The lower line indicates the standard, which is the basic time required to perform a task without rework. The workers are expected to hold fairly close to this curve, and continually increase their efficiency as the units are produced.

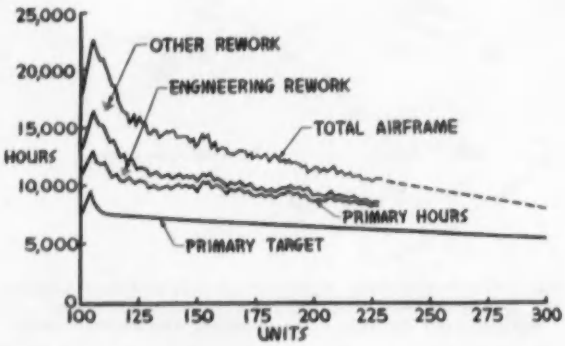


Fig. 5—This on-the-job control chart is posted at the leadman's station. The ordinate is man-hours; abscissa is the number of units produced. The lowest curve (labeled primary target) is the standard. The next curve is the actual primary time expended on each particular unit. The next curve is the actual time including rework due to engineering changes. The top curve is the actual time including primary time, engineering, and manufacturing rework

Fig. 6 shows a weekly summary of performance in all departments. It lists for each department the ratio of A, B, and C workers, the per cent of engineering rework, the per cent of production rework, equivalent units produced for the week, average earned standard hours per unit, average actual hours expended per unit, and efficiency.

Measuring performance . . .

Performance reports, such as those just described, do not cut costs and do not reduce time. They are only instruments to be used by supervisors in deciding where to take action to improve pace, change sequence, shift personnel, or otherwise improve performance. So they must be accurate and the standards must be reliable.

In establishing any performance measuring system, it is suggested that the following steps be taken:

1. Establish cost centers (areas of measurement).
2. Set up reliable standards.
3. Establish a system for measuring production that compares actual to standard times.
4. Establish a system of reports.
5. Provide for follow-up action.

Following up cost control . . .

When performance reports show cost trends that indicate the need for action, there are four steps to take:

1. Investigate the trend to determine the cause.
2. Decide what corrective action is needed.
3. Assign responsibility for such action.
4. Follow-up to make sure that it is done.

	DEPT. NO.	DESCRIPTION	AVG. RATE	% OF RATIO OF JOB CLASSIF.			PERCENT OF REWORK TO PRIMARY		EQUIV. UNITS PROD.	TIME STD.	PRIMARY HRS. PER UNIT	% EFF.
				A	B	C	-32	-35				
SUPT. 'A'	5502	WELDING SHOP		△	△	△	△	△	*6.65	* 402	* 458	*88
	5503	SHEET METAL FABRICATION							*6.26	*2048	*2399	*85
	5508	PROCESS & PAINT							*6.28	*1116	*1338	*83
		PLASTIC SHOP							*4.09	* 523	* 610	*86
SUPT. 'B'	5507	ELECTRICAL & INSTRUMENTS							*5.31	*1405	*1786	*79
	5517	HYDRAULIC & PLUMBING							*4.79	* 356	* 447	*80
	5504	SUB-ASSEMBLY							*5.59	*1138	*1342	*85
	5524	BENCH ROUTER & DRILL ASSY.							*5.86	*1212	*1475	*83
	5594	SPOTWELD, BEARINGS & CABLES							*6.03	* 672	* 807	*83
	5544	ENGINE DOORS & FAIRINGS							*5.38	* 887	*1037	*86
SUPT. 'C'	5510	POWER PLANT INSTALLATION							5.56	234	264	87
	5584-85	OUTER WING ASSY. & INSTALL.							5.46	2697	3147	86
	5586	FUSELAGE ASSY & INSTALLATION							5.68	1633	1931	85
	5587	FUSELAGE SEW-UP & PRIMARY INSTALL							4.91	1523	2147	71
	5588	FINAL ASSEMBLY							5.50	915	1135	81
	5806	RADIO & RADAR							4.16	235	289	81
	5819	PRODUCTION FLIGHT SERVICE							4.26	329	424	78
	5589	F-89 FINAL OPERATIONS							3.35	442	512	86
		TOTAL PRIMARY HOURS							5.55	17,767	21,548	83
	* 4 WEEK AVERAGE								TOTAL AIRFRAME HOURS PER UNIT		27,271	

Fig. 6—This is a summary of all the manufacturing departments' weekly job performance reports. The information tabulated in the columns marked △ are proprietary information and therefore are not shown

Choice of Fuel for Turbine Airliners Narrows to JP-4 and Kerosene

CHOICE of fuel for turbine airliners has narrowed to JP-4 jet fuel and kerosene-type fuels. True, the engine itself can be adjusted to burn almost any hydrocarbon. But considerations of fire safety, engine requirements, freezing point, vapor loss, cost, and availability rule out aviation gasoline, diesel oils, and practically all the other fuels that were suggested in the early days of turbine engines.

JP-4 is a wide-cut petroleum product covering the boiling range of both gasolines and diesel fuels. It was developed to provide a cheap turbine fuel, readily available in sufficient quantities. The Air Forces of the United States, United Kingdom, and Canada have standardized on JP-4 for their turbine operations. It is covered by military specification MIL-F-5624B. Trans-Canada Air Lines has also chosen JP-4 to fuel its new turboprop Viscounts.

Aviation kerosene is made to a variety of specifications covering viscosity, sulfur content, freezing point, and other characteristics. The principal difference is the maximum freezing point. British aviation kerosene is specified at − 40 F, Canadian aviation kerosene at − 55 F, and U. S. aviation kerosene at − 76 F. The lower the freezing point specification, the higher the cost and the lower availability. JP-1 is the U. S. military aviation kerosene. The kerosene being considered by the U. S. airlines will probably have a freezing point in the − 20 to − 40 F range.

JP-4 has a specified Reid vapor pressure of 2–3 psi, which facilitates starting in cold climates and restarting after blowout at altitude.

Besides JP-4 and aviation kerosene, there is one other fuel in current military use, JP-5. This is a

THE accompanying article is based on four papers presented at the SAE Golden Anniversary Annual Meeting, Detroit, Jan. 10, 1955:

"Must Jets Be Pampered?"

H. A. Fremont and E. V. Albert,
General Electric Co.

"Commercial Turbine Fuels—An Approach to Their Selection"

P. E. Lamoureux,
Trans-Canada Air Lines

"An Oil Company's Viewpoint on Civil Aircraft Turbine Fuels"

E. J. McLaughlin and J. A. Bert
California Research Corp.

"An Airframe Manufacturer's Viewpoint on Civil Aircraft Turbine Fuel"

C. A. Weise,
Douglas Aircraft Co., Inc.

Individual papers are available in multilith form from the SAE Special Publications Department at 35¢ each paper to members, 60¢ to nonmembers.

special blending component which, when mixed with aviation gasoline, produces a fuel similar to JP-4. It solves a supply problem for the U. S. Navy.

Here are the basic considerations which have narrowed the choice to two fuels, JP-4 and kerosene, but not singled out either one:

Fire Safety in Flight

JP-4 and kerosene appear to be about as safe as aviation gasoline as far as in-flight fires caused by lightning, engine fire, or contact with hot parts goes. But it's hard to choose between JP-4 and kerosene on this basis.

All it takes to cause combustion—either the rapid combustion we call an explosion or a slower-burning fire—is a combustible mixture of fuel and air plus a source of ignition. Without a combustible mixture, there can be no fire. Fig. 1 shows the flammability limit loops for JP-4 and kerosene, as well as for gasoline and JP-1. These are valid for fuels of average volatility, subjected to low-energy sources of ignition in certain standard test equipment, at equilibrium conditions. Under these circumstances, ignition can take place only at the conditions represented by the area inside the loops. At other conditions, the mixture is either too rich or too lean to burn.

At first glance, kerosene looks safest. The ambient temperature line doesn't enter the kerosene loop at all.

But charts like Fig. 1 don't tell the whole story. For one thing, they assume a low-energy source of ignition. Lightning is a relatively high-energy source and would tend to broaden the loops. For another thing, from batch to batch a given fuel varies somewhat in volatility, as Fig. 2 shows for JP-4. And within a batch, weathering causes a gradual drop in vapor pressure.

What's more, inside an aircraft fuel tank, you don't have equilibrium conditions during flight. During climb and descent, pressure and temperature within the tank vary, and stratification between air and the fuel vapors takes place. The fuel sloshes around continuously, forming fuel-rich mists. Fig. 3 shows how this mist extends the flammability range.

The result of these effects is that in any tank from which fuel is being drawn, there exist at all times all mixtures from pure air to the richest mixture possible under the temperature and pressure conditions prevailing in the tank.

Fig. 4 gives some time-temperature histories of fuel in typical (DC-6) integral fuel tanks during take-off, climb, and cruise at 20,000 ft (outside air temperature of − 13 F). Superimposed are the explosion limits of equilibrium mixtures of various fuels with air, for the same altitude.

With kerosene or heavier fuels, soon after take-off the fuel would be too cool to form combustible mixtures in the vapor space, and no ignition should take

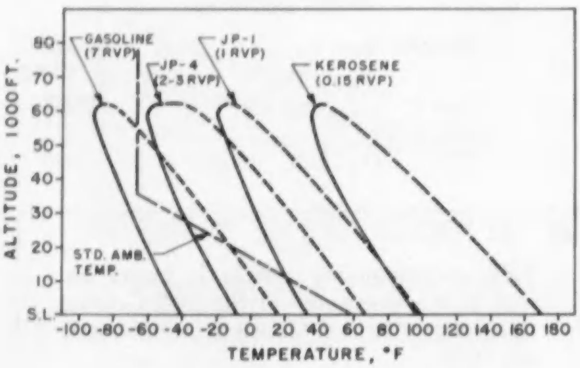


Fig. 1—Flammability loops for four possible turbine fuels

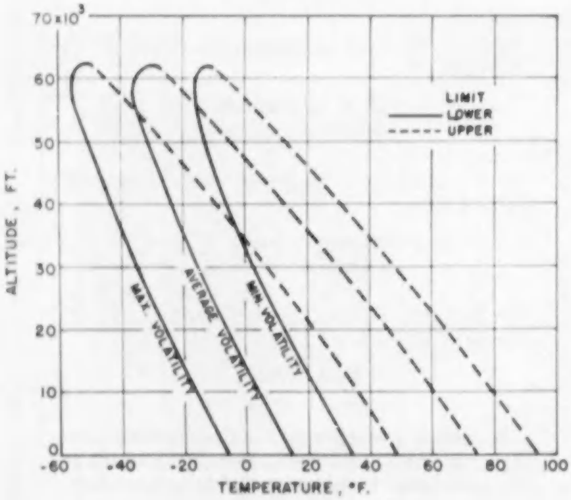


Fig. 2—Flammability loops for JP-4 fuel of minimum, average, and maximum volatility

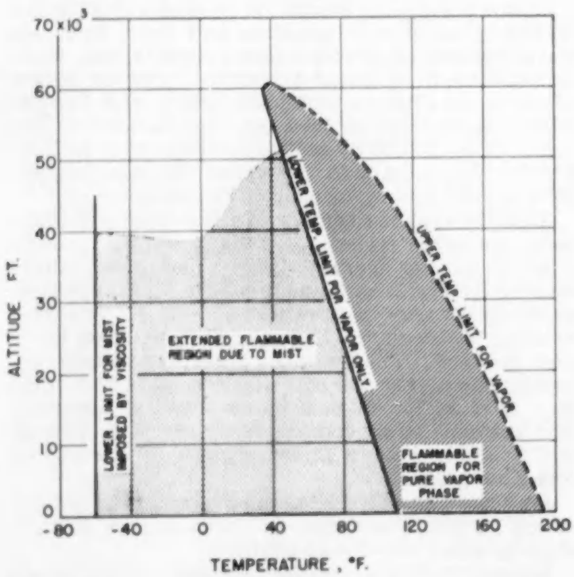


Fig. 3—NACA data on flammability limits of kerosene vapor and mist

place. The vapor pressure of JP-4 does not seem so favorable.

Yet this does not indicate that JP-4 is dangerous, not any more than gasoline. Going back to Fig. 1, we can see that even gasoline vapor goes through the explosive range during descent from a long, high-altitude flight. Yet in 165,000,000 hr of operation of Douglas commercial aircraft from the DC-3 to the DC-7, there has been not one known case of an aircraft fuel tank exploding or catching fire in flight, due to ignition of the vapor by lightning, a spark caused by discharge of static electricity, or other internal sources.

Actually, neither lighting nor static electricity should be a problem. Lightning strikes in regions of small radii of curvature and high air velocity. If the airplane designer locates fuel tanks away from such areas and provides adequate bonding between metal parts, lightning is not hazardous. The bonding prevents any one part of the system from acting as a condenser plate to store up electrical energy, either from lightning or the flow of the fuel.

JP-4 appears to be a little safer than kerosene in the case, too, of a leak of liquid fuel onto a hot part. In general, the higher the volatility, the higher the spontaneous ignition temperature. The more volatile JP-4 appears to have a spontaneous ignition temperature somewhat higher than kerosene. (Actual values depend on the test method used.)

Relative safety of the two fuels in case of a vapor or mist leak depends largely on the rate of fuel emission. If leakage is slight, say a small leak in a low-pressure line, the lower-vapor-pressure kerosene is less of an immediate hazard. If leakage from a high-pressure line forms a mist, higher-vapor-pressure fuels soon form a mixture too rich to explode; with low-vapor-pressure fuels, mists are very great hazards. Also, low-vapor-pressure fuels evaporate more slowly. Spilled or leaked kerosene tends to linger and creep, thus increasing its chance of being ignited.

Fire Safety Following a Crash

Here again the relative fire safety of fuels depends partly on how the fuel is emitted.

If the fuel is liberated as a mist, volatility has little effect on fire initiation and propagation. NACA tests have shown that, in the event of wing damage causing fuel to be lost at the time of crash when the aircraft is still moving at relatively high speed, the fuel stream is broken up into a cloud. This spreads rapidly spanwise and forward. It may even overtake the aircraft as it slows down. In this case, the cloud is sure to include a combustible fuel-air mixture, no matter what the vapor pressure of the fuel.

If a crash liberates fuel in the form of relatively slow leaks, the vapor due to evaporation is the real hazard. The low-vapor-pressure fuels are much safer. Once a fire begins, rate of flame spread across the spilled fuel is proportional to its vapor pressure. The heavier fuels, like kerosene, are safer.

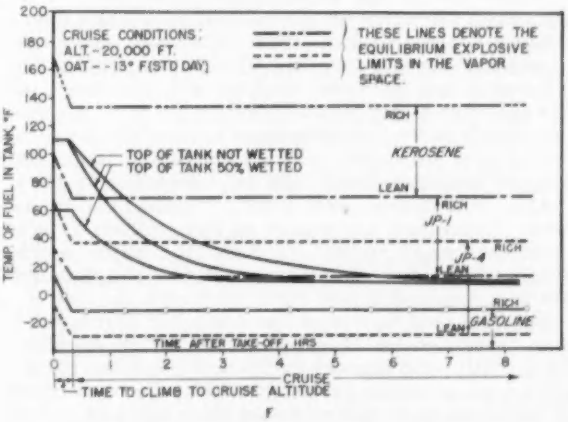


Fig. 4—Typical conditions of fuel inside a DC-6 tank

Fire Safety in Ground Handling

Both JP-4 and kerosene are relatively safe fuels to handle, but there's no cleancut choice between the two on the basis of safety of ground handling.

Pouring fuel into the airplane's tanks at the rate of several hundred gallons per minute churns up fuel mist and spray. JP-4 is likely to form a fuel-air mixture too rich to burn.

There is some evidence that pumping heavy fuels like kerosene generates more static electricity than pumping JP-4 or aviation gasoline. Of course, proper grounding of nozzle to airplane eliminates this hazard. But if the grounding is imperfect, the hazard due to discharge of this static is greater when the humidity is low. Low humidity accompanies low temperatures. In the cold, higher-vapor-pressure fuels may form mixtures within the explosive range, while low-vapor-pressure fuels tend to give mixtures too lean to support combustion. This gives low-vapor-pressure fuels an advantage in most climates. (In hot, dry desert areas, the advantage might, of course, go the other way. Each climate should be considered by itself.)

Spilled kerosene is less likely to ignite because it has a higher flash point than either JP-4 or gasoline. But JP-4 ought to be at least as safe from this standpoint as gasoline.

Engine Requirements

The gas turbine powerplant is not very choosy about its fuel. It will operate satisfactorily on JP-4, kerosene, aviation gasoline, or any of many other fuels—if its atomization equipment and burners are designed for that fuel.

The factors that do matter to the engine and engine builder are:

1. Heat content
2. Volatility
3. Viscosity
4. Corrosivity
5. Foreign matter content (including water as well as solids)

The engine builder can't guarantee power or thrust output unless he can be sure of the fuel's heat content. Volatility and viscosity affect both pumpability and atomization. Corrosivity influences engine weight (the more corrosive the fuel, the

heavier gage material needed) and durability. Water can freeze and plug filters, and so can dirt.

Current JP-4 and aviation kerosene are satisfactory on all these scores.

Airframe Requirements

The airframe restricts the fuel on the counts of freezing point, and boiling and evaporation losses.

Freezing point of JP-4 is, by specification, – 76 F or lower. Freezing points of commercial lamp kerosenes vary from about – 20 to – 40 F. Fuels like stove and furnace oils have freezing points in the range 20 F to – 20 F—which is one of the chief deterrents to their use.

Fuel can, of course, be heated with waste heat from the engine. The equipment weight increase is about 1/3 to 2/3 of 1% of the weight of the fuel carried. The cost in complexity is a doubling of the present type of fuel system. For these penalties, a fuel-heating system could keep fuel at 20 F with – 65 F outside air temperature at 35,000 ft. But, like all self-contained systems, there would be the problem of starting up an airplane which had been left soaking at low temperatures. This might make the whole scheme unattractive.

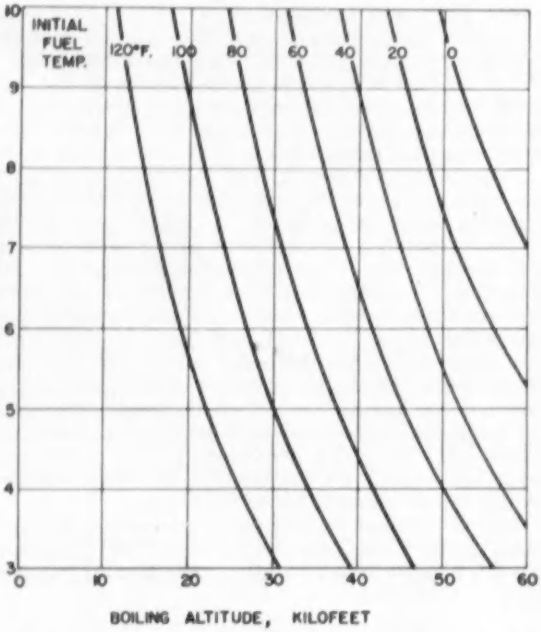


Fig. 5—Effect of vapor pressure and initial fuel temperature on boiling altitude of fuel

The lower the volatility, the less fuel lost from the airplane tanks by evaporation and slugging. Evaporation losses become appreciable as soon as boiling begins. Kerosene, with its Reid vapor pressure of less than 0.5 psi, would not boil at any operational altitude. JP-4, even with a tropical fuel temperature of 100 F, would boil only above 40,000 ft, as Fig. 5 indicates. (In practice, boiling altitude would be higher because of the cooling of the fuel during climb.)

Fuel losses with kerosene or JP-4 would be negligible. But fuels with Reid vapor pressures of 5 to 7 psi would escape too fast—or else require the addition of weighty fuel-pressurization equipment.

Economic Considerations

Fuel cost is a major factor in turbine transport operation because of their higher fuel consumption.

Table 1 summarizes recent relative wholesale cargo prices per gallon, both Gulf and West Coast. (New York and Midcontinent prices are customarily on the same order as Gulf prices.)

Combining the price per gallon and the heating value per gallon into cents per 100,000 Btu—or using gas industry terminology, cents per therm—gives the comparison shown in Table 2. This is useful particularly for an aircraft which is volume limited.

For the more common case of aircraft which are weight limited, heating value per pound must also be considered. Heating value per pound is lower for kerosene than for JP-4. Therefore fuel load for a given number of Btu's (equivalent range) would be greater for kerosene. Less payload could be carried using kerosene.

Each airline will have to weigh for its routes the price differential versus the payload differential.

Trans-Canada Air Lines chose JP-4 for its new turboprop Viscounts on the basis of safety and operational considerations. But TCA sees economic considerations also favoring JP-4. For one thing, the increasing use of diesel engines will cut down on the quantity of crude available for producing kerosene. Only 6–8% of petroleum crudes can be converted to a low-freezing-point kerosene. Some 40–60% of available crude can be converted to JP-4.

Also, TCA figures, even small refineries can make JP-4. Therefore, there may be competition among suppliers, which ought to keep the price down. Furthermore, since small local refiners can produce the fuel, transportation costs may be less.

The fact that U. S. and Canadian Air Forces have already settled on JP-4 means that most oil companies will have storage tanks and handling facilities for it. Aviation kerosene might require erection of extra facilities, which would raise the cost to the fuel consumer.

Table 1—Cost per Gallon

	Wholesale Cargo Prices, Gulf Coast	Cents Per Gallon West Coast
JP-4	9.0	10.8
Kerosene	10.5	12.3
JP-1	9.3	10.5

Table 2—Cost per Therm

	Gulf Coast Cents per Therm	West Coast Cents per Therm
Kerosene	7.1	8.6
JP-1	8.3	9.7
JP-4	7.8	8.8

In Canada, supplies of aviation kerosene have been averaging 18,550 Btu per lb as against 18,875 for JP-4. TCA is interested in the heat content per pound, since its Viscounts are weight limited, rather than volume limited. On the Toronto-to-New York run, for example, the Viscount can carry 140 lb more payload using JP-4 instead of kerosene. On other routes, under adverse wind conditions, the advantage of JP-4 might be as high as 240 lb of payload.

In TCA's case, the airline pays less per Imperial gallon for JP-4 than for kerosene by 1 to 4¢—or an average of 1.5¢. For the TCA fleet of 15 Viscounts, JP-4 is expected to save $190,000 per year over kerosene.

It's Btu's per Lb that Count, Not Just Specific Gravity

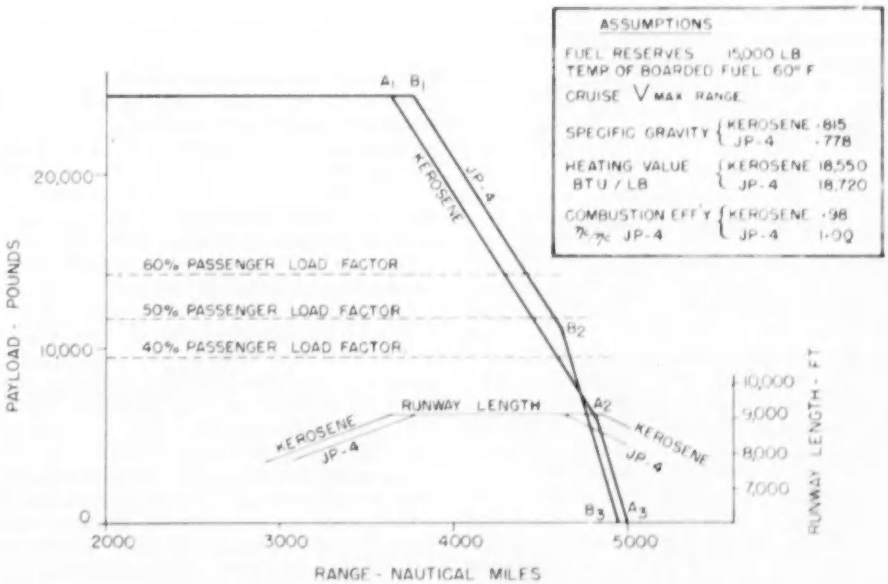
TCA's investigation of several long-range pure jet transports has convinced the airline that high specific gravity of fuels is not synonymous with longer range, as some have believed in the past. This long-range transport range-payload diagram is typical of those for all such aircraft which TCA has studied to date.

Points A1 and B1 represent the range at full payload which is achieved in a typical transport with kerosene and JP-4, respectively. Points A2 and B2 are the ranges achieved with full tanks. Points A3 and B3 are the maximum ultimate ranges which can be achieved with full tanks and no payload.

For the example shown, at all profitable passenger load factors, JP-4 provides approximately 120 miles more range than kerosene at the same payload. Or, for a given range between Point B1 and Point B2 the use of JP-4 will permit approximately 2000 lb more payload to be carried. This difference arises from the fact that JP-4 weighs less for a given number of Btu's and provides slightly higher combustion efficiency. This weight difference can be translated in terms of higher air miles per pound for the airplane using the lighter fuel. (The values for specific gravity, heating values, and combustion efficiency are those quoted by C. A. Weise of Douglas in his SAE paper, "An Aircraft Manufacturer's Viewpoint on Civil Aircraft Turbine Fuels.")

A further advantage of the light-weight fuel is also indicated on the secondary graph showing take-off runway length. Again, because of the lighter weight of JP-4 for a given range beyond Points A2 and B2, the take-off run is reduced by as much as 400 ft in favor of this fuel. On a hot day with full temperature accountability, this difference can be translated into a substantial payload advantage. (For a particular aircraft this amounts to 1500 lb.)

—P. E. Lamoureux



Don't Be Afraid of Engineering Changes

All aircraft companies make engineering changes from time to time. Only by constantly improving the product and lowering the manufacturing cost, can a company keep up with its competitors. In fact, constant revisions of a product is a sign of a strong, progressive company.

1. Are engineering changes necessary?

Engineering changes are inherently part of the aircraft manufacturing process. New requirements and discoveries are constantly making revisions necessary. Some changes may be worked into the product over a period of time without disrupting production too much. Others are mandatory and require immediate adoption.

A change is considered mandatory if (a) the parts don't fit into the final assembly, (b) the parts don't function, or threaten the safety of the aircraft, (c) the customer rejects the part for any reason, (d) the part cannot be manufactured within the specified tolerances, (e) the product quality is not being maintained.

Only about 10 or 15% of all changes are mandatory.

2. Who decides to make a change?

The decision whether a change will be made is usually left up to a Change Board consisting of representatives from Engineering, Sales, Service, Manufacturing, Planning, and Procurement.

Generally, one of these departments will suggest a change to the Board. For example, a change in specifications would originate in Engineering. One which affects the customer would come from the Sales or Service Departments. A change in production methods may come from Manufacturing.

The aircraft company Change Board evaluates the request, sorting out the necessary from the unnecessary revisions. It is placed on a priority list depending upon its importance. Then lead times are worked out to allow for engineering, tooling, material procurement, production processing, manufacturing, and final integration with the main product at a specific effective point.

3. How are changes made?

After the Change Board decides, the information is disseminated to the various departments—sometimes by Gantt cards—and followed up periodically. Each company must tailor its follow-up to suit its own operation. Check lists, which describe the new or changed parts can be "mastered" to a Change Board number which appears on all engineering documents. These lists help Production Control to follow up.

Once an effective point is established the company may have to hold to it, even if it means scrapping inventory and losing money. Therefore, careful pre-planning is necessary. Breakdown must be correct, flow time reasonable, rates and numbers of stations must be accurate, and needed tools, jigs, and materials must be made available.

Changes in a product invariably require changes in tooling. Sufficient lead time must be allowed for installation and testing new tools.

Prototypes, mock-ups and tests are an important check before changes are instituted. Scheduling prototype models from six weeks to several months prior to production will establish initial cycle setups, train the workers, and eliminate many modifications to the change later on.

Changes can be made on the regular production line, on a "parallel" line, or by utility shops.

If a second line is used, gradually it will supercede the old line. This will "prove out" not only the change but the tooling as well.

Utility or other non-production shops have specially trained labor which is qualified to make

. . . Here are the answers to six vital questions which will make your engineering changes easier

George Thompson, Republic Aviation Corp.

Based on the secretary's report of Panel on Lead Time and Engineering Changes held as part of the SAE Production Forum at the SAE National Aeronautic Meeting, New York, April 12, 1954.

hand-made tools and parts on a non-production basis. Mandatory changes can be expedited this way, but it is very expensive.

The best method, if at all possible, is to wait until production tooling is available and run the parts through the regular production facilities.

When a particular part has to be reworked, one shop cannot always handle it alone. Sometimes the part may already be installed in final assemblies or sub-assemblies. Then it's better to rework the part near the place in the plant where the major units are, rather than return them to their original shop. Sometimes the parts must be brought to a utility shop because the original jigs are being used for other production.

One of the major problems of the aircraft accessory manufacturer is getting the major assembly manufacturer to recognize and accept changes in the part. Often these changes require major revisions in drawings, affect spare parts, necessitate new testing programs, and upset installation systems. However, if the change will reduce overall costs, or considerably improve the ultimate product, the change will eventually be made. The responsibility for obtaining acceptance, however, must remain with the accessory manufacturer.

4. How much lead time is necessary?

The time it takes to institute a change from its first inception to effective point depends on the complexity of the company. (In most aircraft companies the time averages about one month.) However, for special important changes, a "hand carried" method can be used to speed up the normal flow time.

Generally, effective point can be improved by releasing the change information in detail as available, rather than holding it for a "package" announcement.

By following up the test and development program closely, the Engineering Department can design and release their final drawings earlier.

5. How much do changes cost?

There is no standard formula for the actual cost of changes. A time ticket can be used to gather up the various elements of cost, such as engineering, tooling, and labor, but often this method is cumbersome.

One method is to place additional allowances into the various department budgets and to watch this budget line for increased costs.

Another way is to evaluate the cost of the parts being terminated and multiply this by the inventory left on hand.

But the most practical method is to have experienced people estimate the cost and compare costs and estimates over a long period of time on a general basis.

Companies which have serious cost problems often can be helped by exchanging ideas with other companies who have found successful change-over methods.

To control change costs, a cost system should be worked out that is best suited to the type of contracts prevalent with the company. For example, the system must be set up according to whether the contract is "cost" plus, "fixed price," or "negotiable" or "target" type.

"Follow-on" revisions, that is, modifying something which has just been manufactured, are very costly. They can be limited by allowing for more testing and prototype work. Also, if Production pre-approves the engineering drawings and suggests modifications to the design at the start, this

will make sure that the parts can be made and tooled properly.

6. How can change-over be simplified?

In the old days, when aircraft production was less complicated, direct contact between the engineer and the worker facilitated changes. Today, Change Boards, Coordinators, Project Engineering Groups, Planning Groups, and Tool Development Groups, seriously complicate change-over. No doubt many of these control groups are necessary, but in the interest of cutting down lead time and red tape, much must be done to simplify the procedure.

Here are some suggestions:

(a) Cut down the number of people needed to approve a change. This can be done by assigning greater responsibilities to fewer people and employing more versatile people who understand the change problem.

(b) Set up a special sub-committee of the Change Board consisting of Engineering, Sales and Manufacturing, who might, by telephone or hand expedited communication, approve changes in advance. This will start the wheels in motion, and get the change into work quicker. This committee could take action between the regular Change Board meetings.

(c) Cut down the number of company approvals required for the engineering change.

(d) Exert more pressure on the customer to release approval sooner. Usually advance cost data can be submitted to a customer for advance approval. Many times the company must take a calculated risk and start the change before complete approval.

(e) For minor changes (those which are not mandatory, or do not affect safety, utility or interchangeability) elaborate, expensive controls are unnecessary. Control by project or work lots, or waiting until the present inventory is exhausted before using the new part, are feasible means of simplifying change-over controls.

(The report on which this article is based is available in full in multilith form, together with reports of the other panel sessions of the 1954 SAE New York Production Forum. This publication, SP-307 can be obtained from SAE Special Publications Department. Price: $1.50 to members, $3 to nonmembers.)

The Car of 2005 . . .

. . . is in the making. Description is impossible, but certain trends suggest what to expect in the way of better, safer automobiles.

Based on paper by **Raymond Loewy,** Raymond Loewy Associates

GRANTED that there are many variables which will affect automobile styling in the 50 years to come, there are also some near-certitudes which can be isolated and their probable effects predicted. There are six of these which stand out prominently:

- Highways will carry more traffic at higher speeds. This will call for better streamlining, smooth undercarriages, higher speeds, and better deceleration.
- There will be more automobiles in use, hence they must be made easier to maneuver.
- Rising productivity will mean more leisure and more long-distance family travel. This will create a demand for more luggage space.
- Semi-automatic driving will make travel easier, more relaxing, and more dangerous. Interior design will have to take this into account. There will have to be devices to protect the driver.
- There will be more two-car families, therefore, there will be a wider variety of lower cost body types. There might be a utility car, or vacation cars offering some of the advantages found in trailers.
- Greater emphasis will be placed on the safety factor. Structural revisions will shift glazed areas and simplify instrument panels.

In the light of the foregoing, our 2005 model begins to take shape. The hood will be low. The engine, being compact, can be placed anywhere and the cooling intake, if any, will be small. The body with its large luggage spaces will be correctly streamlined with smooth undercarriage, and it will be made strong to sustain collision. The window arrangement will be altered and the greenhouse superstructure will be gone. The car will even move laterally for close parking.

The doors, or accessibility panels, will be power-operated and you won't have to crouch to enter. The interior will be de-lethalized and air conditioned. Seats will incorporate a pneumatic network to control resiliency. Since semi-automatic driving will tend to put the driver to sleep, he may wear wrist electrodes, or the steering wheel may transmit impulses, to stop the car when the danger point is approached. The steering wheel must be mounted on a telescoping column.

Visibility will cover a range of 360 deg. Light-reflecting top surfaces will keep the interior cool in summer. There may be low-priced radar for driving in fog. And the flat windshield, which eliminates misleading light reflection at night, may be back in favor. The rear window may be a type that can be opened. (Paper "An Exploration of the Future of Automobile Bodies" was presented at SAE Golden Anniversary Annual Meeting, Detroit, Jan. 13, 1955. It is available in full in multilith form from SAE Special Publications Department. Price: 35¢ to members, 60¢ to nonmembers.)

Hypothetical all-purpose fighter and long-range interceptor are analyzed to show factors affecting . . .

Fighter Fatigue

G. N. Mangurian and P. D. Brooks,

Northrop Aircraft, Inc.

Based on paper "Effects of Operational Factors on Structural Fatigue in Fighter Type Aircraft" presented at the SAE National Aeronautic Meeting, Los Angeles, Oct. 9, 1954. This paper will be published in full in 1955 SAE Transactions.

TO show the effect of various operational factors on structural fatigue in fighter-type aircraft, two hypothetical planes were analyzed. The design and operating characteristics of the two aircraft were arbitrarily chosen as similar to those of aircraft currently being designed to assess the effects of such factors on the life expectancies of two representative types having contrasting basic missions.

One of the hypothetical planes was a typical all-purpose fighter, the other a typical long-range interceptor.

The all-purpose plane was designed for a relatively high-limit load factor (7.5 g), for a high Mach number (1.6), and for short-range missions. It was assumed to spend 50% of its life on high-altitude missions, and 50% on low-altitude missions. The two portions were combined in the analysis to give a typical all-altitude, short-range fighter.

The interceptor was designed for a lower-limit load factor (5.5 g), for a high Mach number (1.6), and for high-altitude long-range missions.

Fatigue-life factors analyzed included the effect of gust loads, maneuver loads, landing-taxi loads, and the ground-air-ground cycle encountered in service; also, the aircraft's design limit load factor, its design range, its intended combat and cruising altitude, the basic type of mission to be flown, and similar built-in design characteristics.

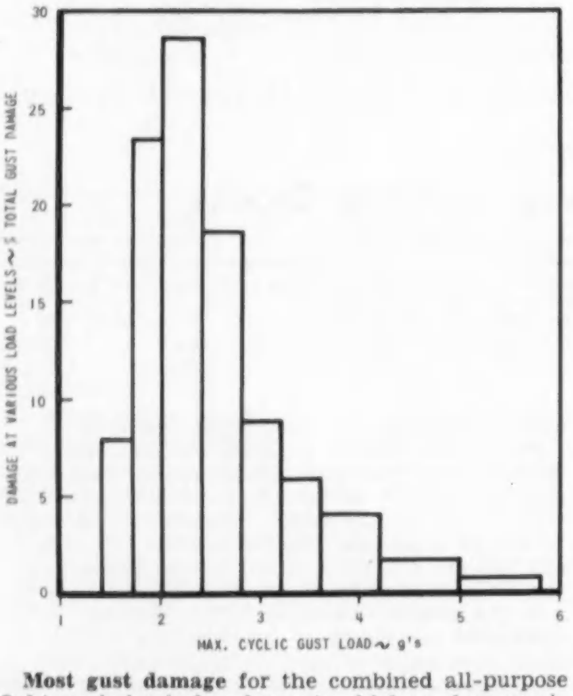
In the graphs and tables below, "damage" is the calculated percentage of the total life of the airplane that has been used up in 100 hr of flight by gust, maneuvering, or landing-taxi loads, or due to the ground-air-ground cycle.

For example, it was calculated that the total cumulative damage resulting from maneuvering loads for the long-range interceptor was 0.0085 in 100 hr, or a loss of 0.85% of its life expectancy. This represented 80.1% of the total damage incurred in 100 hr flight by all operational loads.

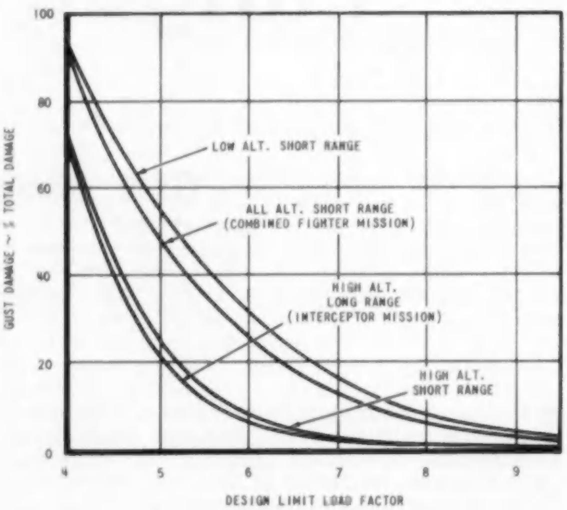
More specific analysis follows on the next page.

DESIGN LIMIT LOAD FACTOR	BASIC MISSION	GUST DAMAGE $\Sigma(n/N)$	GUST DAMAGE % TOTAL DAMAGE	MANEUVER DAMAGE $\Sigma(n/N)$	MANEUVER DAMAGE % TOTAL DAMAGE	GND-AIR-GND DAMAGE $\Sigma(n/N)$	GND-AIR-GND DAMAGE % TOTAL DAMAGE	TOTAL DAMAGE IN 100 HR	LIFE EXPECTANCY (HR)
5.5 *g*	Fighter mission, high-altitude portion	0.0047	13.2	0.0245	69.0	0.0063	17.8	0.0355	2820
	Fighter mission, low-altitude portion	0.0422	42.1	0.0417	41.6	0.0163	16.3	0.1002	1000
	Fighter mission, combined	0.0237	35.5	.0329	49.2	0.0102	15.3	0.0668	1500
	Long-range interceptor mission	*0.0014*	*11.9*	*0.0085*	*72.0*	*0.0019*	*16.1*	*0.0118*	*8470*
7.5 *g*	Fighter mission, high-altitude portion	0.0007	2.2	0.0245	77.8	0.0063	20.0	0.0315	3170
	Fighter mission, low-altitude portion	0.0075	11.4	0.0417	63.7	0.0163	24.9	0.0655	1530
	Fighter mission, combined	*0.0041*	*8.7*	*0.0329*	*69.7*	*0.0102*	*21.6*	*0.0472*	*2120*
	Long-range interceptor mission	0.0002	2.0	0.0085	80.1	0.0019	17.9	0.0106	9430

The total damage incurred during 100 flight hours by each hypothetical type of mission, and the overall life expectancies are shown above. The values for the two basic design missions (all-purpose fighter designed to 7.5 *g* and long-range interceptor designed to 5.5 *g*) are in underlined italic type. The life expectancy of the long-range interceptor is roughly four times that of the combined all-purpose fighter when each is flying its design mission. Note that the largest portion of damage in each case is done by the maneuver loads. If dynamic response effects had been taken into account, and if structural flexibility had been assumed, the relative amount of gust damage would have been larger.



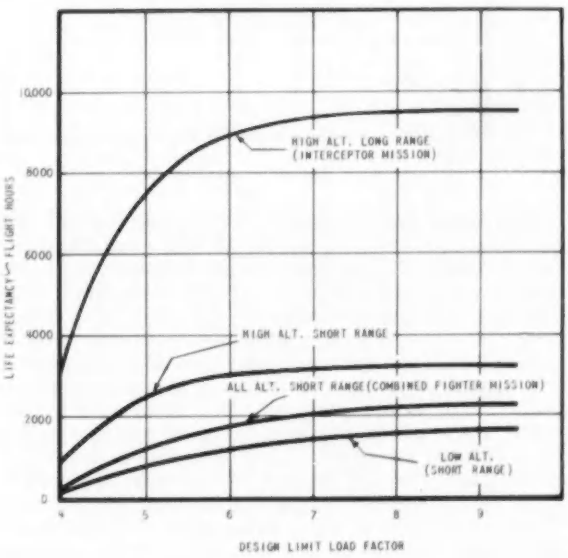
Most gust damage for the combined all-purpose fighter mission is done by gusts which produce maximum accelerations of between 1.7 and 2.8 *g*, the peak damage occurring at around 2.2 *g*. For a Mach number of 0.9 and an altitude of 10,000 ft (the speed and altitude at which most of the gust damage occurs), this load factor is equivalent to a gust velocity of 18 fps. There is virtually no damage done by gusts at accelerations above 5.5 *g*.



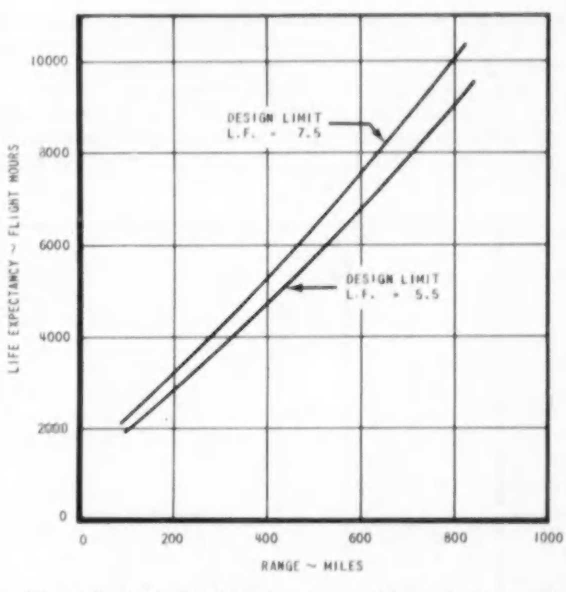
Damage inflicted by gusts on planes which are designed for higher load factors (above approximately 7.0 *g*) is quite low. In the lower design load factors, however, gust effects become increasingly significant, and below about 5.5 *g*, gusts cause a relatively large amount of the total fatigue damage. At any load factor, the low altitude and combined altitude missions show greater relative gust damage than the higher altitude missions. A plane which is designed to 5.0 *g*, and which flies between 50 and 100% of its lifetime at low altitude, would experience gust damage amounting to around 50–55% of the total damage from all causes.

FLIGHT PHASE	ALL-PURPOSE FIGHTER				LONG-RANGE INTERCEPTOR			
	GUST DAMAGE %	MANEUVER DAMAGE %	GROUND AIR GROUND DAMAGE %	TOTAL DAMAGE %	GUST DAMAGE %	MANEUVER DAMAGE %	GROUND AIR GROUND DAMAGE %	TOTAL DAMAGE %
Climb and descent	2.0	6.7	4.3	13.0	11.9	11.7	3.2	26.8
Cruise out and back	4.4	2.3	NEGL.	6.7	NEGL.	12.0	NEGL.	12.0
Combat or intercept	2.3	60.7	17.3	80.3	NEGL.	48.3	12.9	61.2
Total	8.7	69.7	21.6	100	11.9	72.0	16.1	100

The individual damages resulting from each phase of the two basic missions are presented in terms of percent of total damage. This may also be interpreted as representative of the percent life lost by the two planes in various phases of their overall missions. Because of the predominance of maneuver damage, the largest percentage of life is lost in the combat and intercept phases. The largest relative amount of damage done by gust occurs in the climb and descent phase for the interceptor and in the cruise phase for the all-purpose fighter. The latter circumstance is the result of the large damage done by gusts in the cruise phase of the low altitude portion of the mission.



Life expectancy for all types of assumed missions as a function of design limit load factor is presented above. As indicated by the leveling off of all curves, the load factor, as a parameter, becomes unimportant above values around 7.5 *g*. On the other hand, it becomes of major importance below about 6.0 *g*. The interceptor designed to 5.5 *g* and assumed to fly 100% high-altitude long-range missions would have a life expectancy of around 8500 hr. If this plane were used entirely in high altitudes but with shorter-range missions, its life expectancy would drop to about 2800 hr, a 67% decrease. If it were flown entirely in all-altitude short-range missions, its life expectancy would become approximately 1500 hr, an 82% decrease. This is of major significance in design considerations concerning intended service use of a specific fighter type aircraft.



The effect of mission range on life expectancy is considerable. A plane intended for long-range high-altitude missions, but which is used in short-range high-altitude flying, may experience a reduction in life expectancy of more than 1000 hr for each 100 miles of decreased range. This is primarily because the largest amount of fatigue damage is incurred during combat. A shorter range airplane encounters combat periods more frequently, resulting in this damage being inflicted more often in a given number of total hours. The life of such a plane would therefore be expended more rapidly in short-range flying. The effect of design limit load factor on life as a function of range variation is relatively unimportant.

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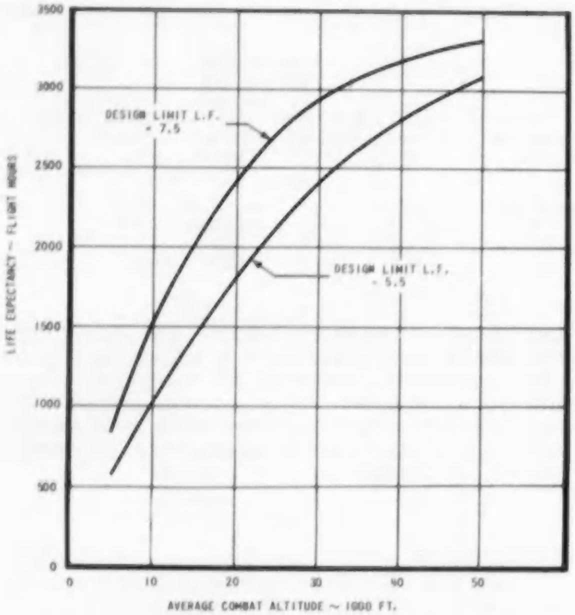
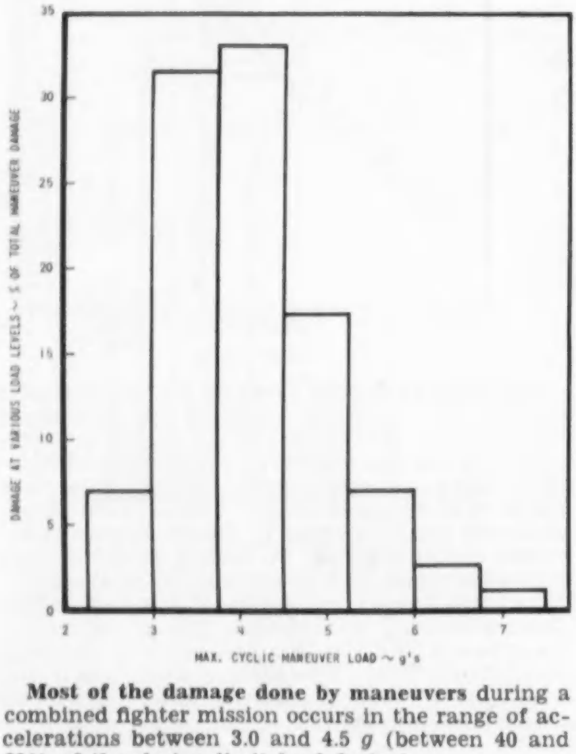
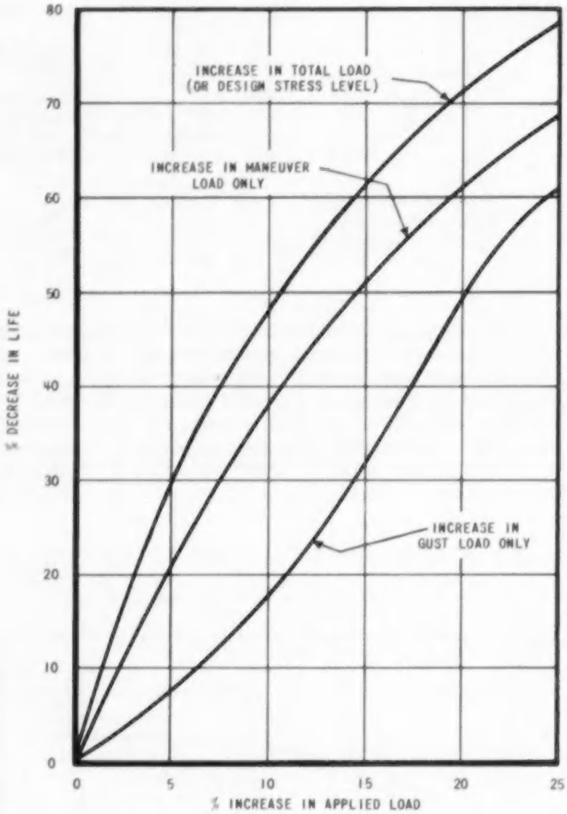


A plane which is designed to a limit load factor of 5.5 *g*, and which is intended to fly combat at an average altitude of 40,000 ft (operating between 30,000 and 50,000 ft), could be expected to have a life expectancy of around 2800 hr. If, however, this plane were actually operated at an average combat altitude of 10,000 ft, its life expectancy would drop to approximately 1000 hr, a decrease of 64%.



Most of the damage done by maneuvers during a combined fighter mission occurs in the range of accelerations between 3.0 and 4.5 *g* (between 40 and 60% of the design limit load factor).



Increased applied loading intensity affects life considerably. During actual service operation, the relative magnitudes used in this article for gust or maneuver loads could be considerably exceeded. For example, a fighter which is operated in weather conditions that are 20% more severe than the estimated level used in design may lose as much as 50% life expectancy. A 10% increase in the gust spectrum alone would result in 18% reduction in life expectancy, which would amount to 360 hr less life for a 2000-hr airplane. A 10% increase in maneuver loading alone would cause a 38% drop in life expectancy, while a 10% increase in all load levels would decrease the life by about 48%. Note that the upper curve can be used to find the effect of an increase in the design stress level established for the critical structure. It is desirable to set up a design stress level which may be considerably lower than the actual static allowable of the material or structural configuration.

(Paper on which this abridgment is based is available in full in multilith form from SAE Special Publications Department. Price: 35¢ to members, 60¢ to nonmembers.)

New welding, forming, forging, and machining techniques are sought because . . .

Titanium is Tough to Handle

J. G. Stefanich, Research and Development Division, Detroit Arsenal

Based on paper "Utilization of Titanium for Tank-Automotive Components," presented at SAE Automotive Ordnance Day, Center Line, Michigan, Feb. 28, 1955.

TITANIUM possesses qualities that make it highly desirable for use in automotive and tank vehicles. But these same qualities make it necessary to develop new techniques in welding, forming, forging, and machining. The Army Ordnance Corps at the Detroit Arsenal is currently investigating new fabrication techniques.

Why titanium is so desirable

Titanium is equivalent in strength to most heat-treated steels and only 56% as heavy. Its resistance to corrosion is considerably better than that of aluminum or steel. It possesses excellent qualities of ductility as well as high fatigue values. These qualities would permit the weight of a vehicle to be reduced without sacrificing strength.

For example, if the suspension system of a tank was to be made of titanium alloys, a reduction of weight up to 2.5 tons would be possible. By using titanium instead of rolled, homogeneous steel for armor plate, a weight saving of 40% would be possible. Other direct advantages would be to reduce the size of the powerplant and increase the mobility of the vehicle.

Fabrication know-how is sought

From its experimenting with titanium arc welding, forming, forging, and machining, the Detroit Arsenal has discovered:

1. Welding requires inert gas

Welding techniques have been limited to three processes, each of which involves an inert gas shield to protect the molten metal from oxygen, nitrogen, or hydrogen. Even the smallest amount of these elements causes the welding joint to become brittle.

The tungsten arc process was found to be satisfactory, but slow. The metal arc process proved best for welding heavy plate and the tungsten arc with automatic wire feed could be used for plate up to ¼ in. From the results of this investigation and because the metal arc process has a high current density and a high deposition rate, this technique was used for further experiments.

Restrained and unrestrained butt-type welded specimens were prepared for impact tests. The unrestrained welded joint specimen consisted of two 6 × 12-in. plates butt-welded along the 12-in. length. The restrained type weld specimen consisted of a

12 × 18-in. plate with a 12-in. length weld groove cut in the center of the plate parallel to the 18-in. length. These were made of 7% manganese titanium alloy. Mechanical tests on this type weld produced an average charpy V-notch impact result of 20.0 ft-lb with the charpy bar taken across the weld joint. These results led to a decision to construct an experimental cab structure having welds 60 in. long and employing the same techniques which were used on the test specimens.

Observations immediately following the welding displayed no cracks, but cracking became evident in the weld within 48 hr. Further observations disclosed that the number of transverse cracks increased with aging up to a period of three months. It was believed that although sound welds were produced in 12-in. laboratory specimens, cracks resulted in the structure because of the increased weld length and the strain induced from forces applied while straightening the plates during the welding operation.

Automatic welding and processes which required preheats and postheats were purposely avoided during early work because it is undesirable to preheat during construction; and automatic welding does not lend itself easily to corners or irregular surfaces. However, it later became necessary to devise such a technique. Some 50-in. straight welds and circular patch welds (which are considered to be highly stressed) were successfully produced. Joints having 60 deg, single V bevel with a 0 + 1/8-in. root opening seemed to be the most suitable.

The effects of unalloyed titanium as well as various alloyed wires were also analysed. The unalloyed wire, when used to weld 7% manganese titanium base metal, produced high strength ductile welds having good impact toughness. Welds produced with alloy titanium wire and a similar alloy base metal were brittle and unsatisfactory.

2. Forming is successful above 900 F

Numerous experiments were made to form tank road wheel discs having a metal thickness of ½ in. and a flange bend radius of ½ in. Temperatures for this operation ranged from 500 to 1000 F, but all attempts to form a disc at temperatures below 900 F proved unsuccessful. Ninety degree cold bend radii for titanium are specified in military specifications MIL-T-12117 (ORD).

3. Forging is successful between 1400 and 1850 F

Forging presented no major problems. However, dies used for forging steel parts will produce larger titanium forgings because of the difference in the coefficient of expansion of the two metals. Conventional gas-fired or electric ovens may be used to bring the metal to temperatures between 1650 and 1850 F. The forging operation may continue until the metal temperature decreases to 1400 F. Below this the metal has a marked resistance to flow. Above, rapid contamination by oxygen and nitrogen will cause surface embrittlement. Also heating above 1850 F causes excessive grain growth which results in poor ductility. Grain refinement cannot be accomplished by subsequent heat-treatment.

4. Machining is difficult due to carbon content

Several grades of titanium alloys were tested for machinability. While it is true that machining of titanium alloys is quite similar to that of stainless steel, excessive carbon content was found to be one of the principle causes of poor machinability due to the abrasive qualities of the carbides. With caution, alloys can be machined satisfactorily, provided the following are observed:

1. The tools must be rigidly supported at all times to prevent excessive vibration.
2. Sharp tools must be employed. For steady cutting, tungsten carbide tools proved satisfactory; for intermittent cutting, high speed tools (7 to 8% cobalt) are recommended. Cobalt-base, chromium carbide tools are most useful when cutting into the higher strength titanium metals.
3. A steady cutting feed must be applied so that the tool will not ride on the work. Cutting tools should be engaged at all times for longer tool life.
4. Proper coolants must be used to minimize galling and seizing and to keep heat at a minimum.

Titanium has deficiencies

Like all other metals titanium has deficiencies. Here are some of the most important:

1. Titanium is not suitable in applications involving temperatures above 800 F. This is a disappointment in view of its high melting temperature (3150 F) as compared with steel (2800 F).

2. Its ultimate yield strength drops rapidly above 800 F. In cases where this decline can be tolerated, the irreversible absorption of oxygen and nitrogen in most titanium alloys causes brittleness, and extended exposure makes the metal unfit for structural use.

3. Titanium has a tendency to gall under sliding contact. Sliding surfaces must be steel-faced or bushed.

4. Titanium cannot be welded to dissimilar metals. Brazing titanium to dissimilar metals is still not satisfactory.

5. Unalloyed titanium has a modulus of elasticity of 15,000,000 psi, which compares favorably with aluminum (10,400,000 psi) and poorly with steel (29,000,000 psi).

6. Casting of titanium is still commercially impractical.

(Paper on which this abridgment is based is available in full in multilith form from SAE Special Publications Department. Price: 35¢ to members, 60¢ to nonmembers.)

Based on discussion . . .

C. A. Nagler, Metallurgical Consultants, Inc.

The optimum conditions in armor plate using present chemistry and methods of manufacture have been produced. I seriously doubt that there will be much competition from titanium as an armor material in tanks, or other armored vehicles.

Aircraft Performance . . .

. . . is improved by blowing boundary layer control. Resultant increase in flap effectiveness reduces take-off, climb, and landing speeds about 25%.

Based on paper by **Dean Kenneth Razak,** School of Engineering, University of Wichita

THE increasing wing loadings of modern commercial and military aircraft have spurred research in the field of boundary layer control to improve flap effectiveness. With a more effective system is produced a higher wing lift coefficient, a reduction in take-off, climb, and landing speeds, and consequent reduction in landing and take-off distances.

The boundary layer may be defined as that film of air immediately adjacent to a surface which is retarded by viscous forces and therefore moves at a velocity less than that of the free stream. Boundary layer formation results in both direct and indirect actions. The direct action is the dissipation of energy by the viscous shear which produces the skin friction drag on the aircraft. The indirect action is the flow reversal in the boundary layer resulting from decreased kinetic energy which can produce turbulent separation, wing stall, and various secondary flow patterns.

One method of boundary layer control maintains laminar flow over the wing surface to prevent the development of a turbulent boundary layer. It requires the use of perforated, porous, or slotted surfaces, and is particularly important for aircraft flying at very high speeds at low lift coefficients. A successful system contributes great benefits, but it is one of the most difficult problems yet tackled by the aerodynamicists.

Other methods prevent or delay the development of turbulent flow separation on deflected flaps or on bluff bodies such as fuselages, struts, or fillets. The fact that the layer may be laminar or turbulent is disregarded. Primary attention is paid to the prevention of adverse pressure gradients, the removal of low-energy boundary layers by suction, or its stimulation by the injection of high energy air behind the point of pressure gradient reversal.

There are four essential features in a system of boundary layer control by injection of high energy air or blowing. These are:

1. A primary source of pumping power. The main engines or an auxiliary engine may be used. An auxiliary powerplant, probably a turbine engine, is recommended for large transports.

2. A method of transmitting the pumping power to the fans. If an auxiliary turbine is used, one of the better methods is to use compressor bleed air for driving turbines that power the boundary layer fans.

3. A system of ducts, usually behind the 60% point of the wing chord, for spanwise air distribution.

4. A blowing slot disposed ahead and above the single slotted flap. This is shown in Fig. 1. The width of this slot is an important design variable and must be coordinated with the other design elements of flap-chord ratio, flap deflection, and pressure and quantity of the blowing air.

The location of the main engine and pumping fans is quite flexible, but the duct installation and slot width selection must be closely controlled to secure maximum lifting effectiveness for the power consumed.

A direct result of boundary layer control is the improvement of the maximum lift coefficient that can be developed with a conventional wing. For wings with flap spans of about 75%, maximum trimmed lift coefficients of about 3.3 to 3.5 can be secured, with thrusting power off. Values of lift coefficients with power on will increase to 4.5 to 5.0. These lift coefficients can be attained with wing lift/drag ratios ranging from 5.0 at the highest lift coefficient of 8.0 to values of 8.0 at lift coefficients of 3.2.

With higher lift coefficient, you can get a given amount of lift at lower flight speed. With boundary layer control, the heightened coefficient-of-lift values make it possible to take off, climb, and land at speeds about 25% below present practice. The landing and take-off distances vary almost directly as the lift coefficient and will therefore decrease from 40 to 50%. Sufficient flight testing has been performed to indicate that, with proper design, no stability or control problems will be met in utilizing these lift coefficients. (Paper "Boundary Layer Control by Blowing—A Method of Increasing Flap Effectiveness" was presented at SAE Los Angeles Aeronautic Meeting, Oct. 8, 1954. Complete paper outlines the design procedure for a system of blowing boundary-layer control. Paper is available in full in multilith form from SAE Special Publications Department. Price: 35¢ to members, 60¢ to nonmembers.)

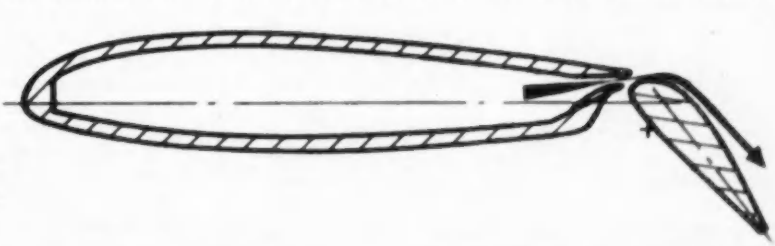


Fig. 1—In this profile of a blowing airfoil the blowing slot is placed ahead and above the single slotted flap to prevent turbulent-flow separation on the upper surface of the flap, establishing again a stagnation point at the flap trailing edge.

High Temperature-High Speed

Lubricants . . .

Extreme temperatures in aircraft turbines impose severe requirements on lubricants. Synthetics and solids may be answer

THE broad and extremely high temperature range occuring in modern aircraft turbine engines invites considering switching from petroleum lubricants to synthetic or solid lubricants. Present-day liquid lubricants are limited by their evaporation, decomposition, and oxidation characteristics. For high temperatures and rotative speeds, synthetic, solid, or gaseous lubricants seem to be more stable.

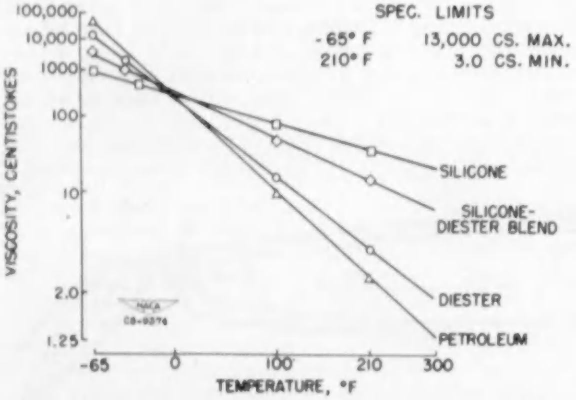


Fig. 1—The viscosity-temperature properties of various classes of fluid are shown. Silicons have the best properties.

Petroleum Lubricants Limited To Below 260 F

Above 260 F petroleum lubricants in general use at present tend to evaporate excessively. Also, their viscosity is too low to lubricate adequately high speed, high-temperature moving parts. It would be possible to increase the viscosity for high temperature use, but the lubricant must also have a low viscosity so that it can be pumped at very low temperatures around – 65 F.

So, to meet requirements at both ends of the temperature range, there is a need for a lubricant with a higher viscosity and lower volatility than current lubricants at high temperatures, and lower viscosity than current lubricants at low temperatures. In other words, on the temperature-viscosity graph shown in Fig. 1, a flatter curve is more desirable.

Some Synthetics Are Better Lubricants

In Fig. 1, it is apparent that diesters have better temperature-viscosity properties than petroleum. And silicons have the flattest curves of any known liquid. But they are poor lubricants for ferrous alloys. By blending silicon and diester lubricants, good viscosity-temperature properties can be had. As shown in Fig. 2, the upper temperature limits for synthetics are much higher than for petroleum.

If the lower temperature specification could be relaxed (that is, by using lubricants of higher viscosity) the upper limits could be pushed up almost 200 F further. But, considerably more research is

CONTINUED ON PAGE 63

Aircraft Turbines Seek New

. . . and Bearings

New bearing materials and designs are being considered for extreme conditions

MATERIALS currently used in rolling contact bearings are inadequate at the high temperatures and rotative speeds occuring in modern aircraft turbine engines. But there are several materials with promising friction and wear properties available for high temperature use. And with proper cage and bearing design, it's possible to increase the limiting speeds of bearings lubricated with liquids.

Rolling Contact Bearings Preferred

The rolling contact bearing is favored over the hydrodynamic bearing in most aircraft turbine engines because of:

(1) extreme low temperature starting
(2) low starting torque without preoiling
(3) much less sensitivity to oil-flowing interruptions
(4) greater freedom in alignment tolerances
(5) lower oil-flow and cooling load (under certain conditions)

A picture of a high-speed roller bearing with its various components is shown in Fig. 3 (a).

Races and Rolling Elements

There are eight basic requirements of materials for races and rolling elements of high speed-high temperature bearings:

(1) Minimum hardness between R_c55 and 58 (at operating temperature)

(2) Critical alloying elements (particularly tungsten) held to a minimum

(3) Resistant to oxidation

CONTINUED ON NEXT PAGE

This article is based on
"Temperature Limitations of Petroleum, Synthetic and Other Lubricants in Rolling Contact Bearings,"
by Z. N. Nemeth and W. J. Anderson,
presented at SAE Fuels and Lubricants Meeting, Tulsa, Nov. 5, 1954; and

"Bearings and Lubricants for Aircraft Turbine Engines,"
by R. L. Johnson and E. E. Bisson,
presented at SAE Golden Anniversary Annual Meeting, Detroit, Jan. 12, 1955. Authors are Aeronautical Research Scientists, Lewis Flight Propulsion Laboratory, National Advisory Committee for Aeronautics.

Readers should bear in mind that some of the applications referred to in this article are special military applications involving total equipment life of only a very few hours.

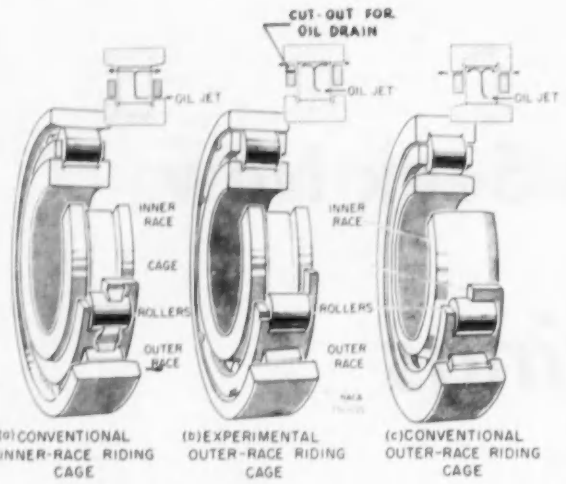


Fig. 3—Various cage and bearing designs have various postulated oil flow patterns. The experimental bearing (b) performed much better than either of the other two conventional designs.

(4) Good fatigue properties

(5) Reasonable heat-treatment and grinding characteristics

(6) Readily available from several sources

(7) Compatible with the cage material in friction and wear properties

(8) Dimensional stability at operating temperature

The standard material of most rolling contact bearings is SAE 52100 chrome steel. It is limited to a temperature range of − 65 to 350 F. Above that, hardness decreases rapidly and dimensions change. So another kind of material is needed.

On the basis of hot-hardness and dimensional stability only, the high-speed tool steels appear promising. But fatigue life of tool steel bearings is not known and very few data are available on the use of such bearings in full-scale turbine engines under severe conditions. Tool steels are not as "clean" metallurgically as SAE 52100, and freedom from inclusions is a requirement for good fatigue

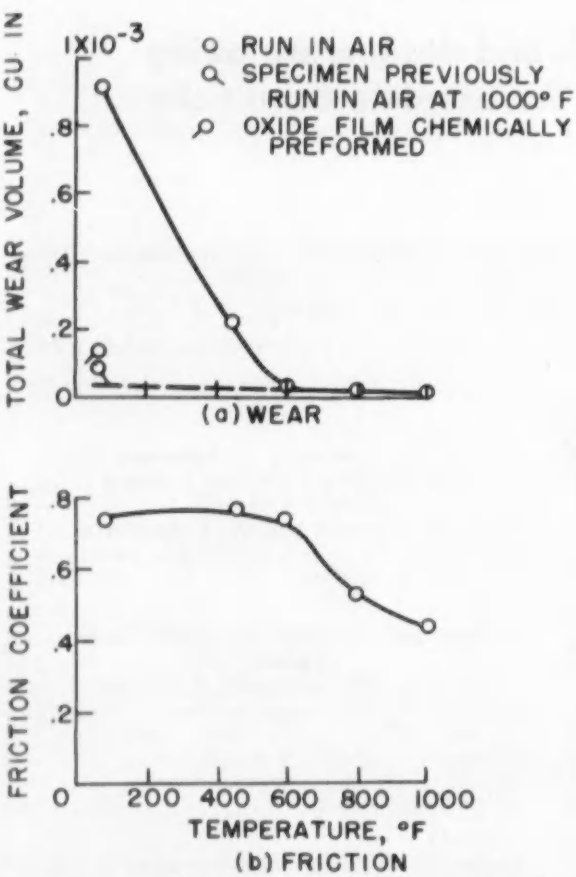


Fig. 4—The wear and friction coefficient of cage materials rubbing against M-10 tool steel, at two temperatures. The amount of wear is indicative of ability to form easy-sliding surface film.

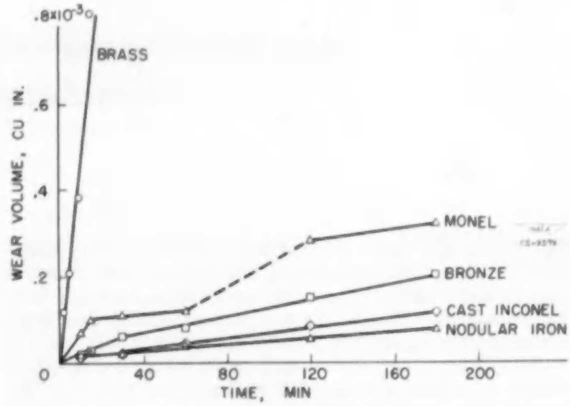


Fig. 5—The wear of various cage materials against 52100 steel, unlubricated. A metal which forms a film on a sliding surface makes desirable cage material.

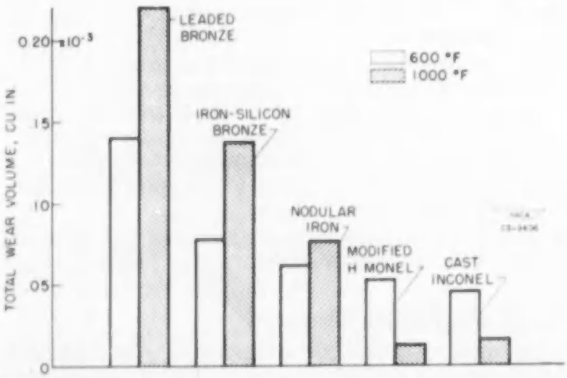


Fig. 6—With Inconel as cage material, wear and surface damage actually decreases as temperature increases, due to formation of NiO on surface.

life. Also, tool steel bearings are very difficult to fabricate because of the difficulty in grinding. So, the high temperature bearing material problem is far from solved.

Cage Material Must Be Compatible

The materials used for bearing cages have four basic requirements:

(1) adequate strength at operating temperatures

(2) resistance to oxidation

(3) thermal expansion coefficient approaching that for the race material

(4) compatibility with race materials

Compatibility from a friction and wear standpoint is the most important requirement because the cage is one of the major trouble points. If adequate lubrication is not maintained severe wear, welding, metal transfer, or "pick up" frequently occur at these surfaces. The best solution to this problem is to use as the cage material a metal which is inherently non-welding when sliding against its mating surface even under severe conditions. For example, in extreme boundary lubrication the properties of the materials in contact are more important than the properties of the lubricants, since metal-to-metal contact is occurring.

Figs. 4 and 5 show a comparison of the wear and surface damage of materials used for cages. These data are indicative of the ability of the material to form a film on its surface which prevents welding. These films are probably supplied from within the structure of the nodular iron by graphite carbon and of the bronze by lead. Monel and nickel probably form an oxide film. Generally speaking, a metal which can naturally form a film on a sliding surface will make a desirable cage material. At high temperatures, cast Inconel has very favorable wear properties. In fact, at temperatures between 600 and 1000 F, wear is approximately 1/20 that at 75 F, as shown in Fig. 6.

Tests point out the beneficial effect of the nickel oxide film on both the wear and prevention of surface damage.

Cage and Bearing Design Determines Performance

By designing a cage so that a lubricant can flow easily into, through, and out of the bearing, and adequate cooling is had, it's possible to extend the limiting speeds. For example, an experimental design shown in Fig. 3 performed much better than the two conventional inner-race-riding and outer-race-riding cages. This is due to the relative ease of lubrication and cooling, and of the adequate oil flow paths which minimize oil churning and friction losses. The experimental bearing operated at lower temperatures for equivalent speeds and had a higher failure speed than either of the conventional bearings.

(The papers upon which this abridgment was based are available in full in multilith form from SAE Special Publications Department. Price: (each): 35¢ to members, 60¢ to nonmembers.)

. . . Lubricants—

CONTINUED FROM PAGE 60

required on synthetic liquid lubricants at high temperatures to determine their thermal and oxidative stability as well as their lubricating effectiveness.

Because presently known liquids suitable for use as turbine engine lubricants are limited to relatively low temperatures, solid lubricants must be considered for the higher temperatures.

Solids-in-Air-Mist Lubricate Up To 1000 F

Solids-in-air-mist lubricants are superior to liquid lubricants at high temperatures and low speeds. Solid lubricants are stable at high temperatures, or else their stability does not adversely affect the frictional properties of the surfaces. Molybdenum disulfide is one such solid. It's possible to operate conventional rolling contact bearings, lubricated with molybdenum disulfide air mist at temperatures up to 850 F, or at high speeds up to one million DN. (A DN value of one million is equivalent to a rotative speed of 13,500 rpm for a 75 mm bore bearing.)

Even better results can be obtained by using graphite-air-mist lubricant, especially at temperatures approaching 1000 F. The difference in results between graphite and MoS_2 is probably due to the properties of their decomposition products. Graphite decomposes to form a gas which could conceivably form a non-oxidizing atmosphere and thus help high temperature bearing performance. MoS_2,

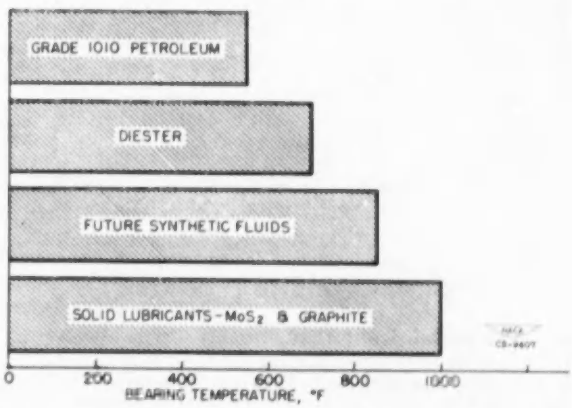


Fig. 2—The upper temperature limits for solid lubricants are higher than for petroleum, diesters, or synthetic fluids.

however, oxidizes in the presence of air at high temperatures, forming an abrasive oxide.

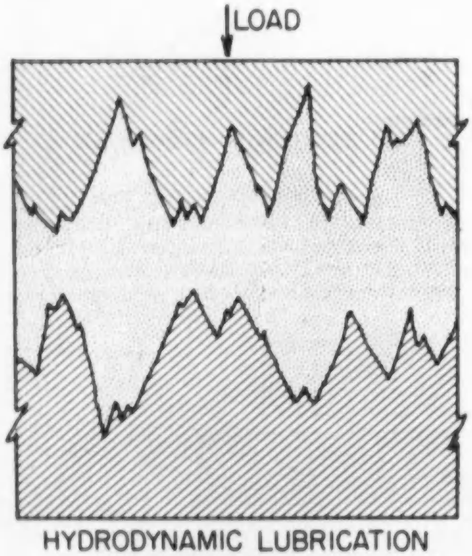
Coating sliding surfaces with a solid lubricant, such as syrup-bonded MoS_2 is not as effective as the air-mist technique.

Gases, such as air, are even more stable at high temperatures than air-mist lubricants.

Air Lubricant Doubles As Bearing

One possible solution to the high temperature problem is using air as the bearing fluid. The air has a different function than in the air-mist system. The load is supported by air in an externally pressurized hydrodynamic bearing. The air bearing has the advantage of being generally unaffected by temperature except to show an increase in load-carrying capacity. It is not subject to fatigue failure either. Disadvantages are the need for a high pressure air source, possible instability due to vibration or flutter, and the need for small clearances and careful alignment. Tests show that air bearings have promise of being able to support loads in a relatively stable manner at temperatures up to 1000 F. Much more research is required, however, on both solid and gaseous lubricants under actual operating conditions.

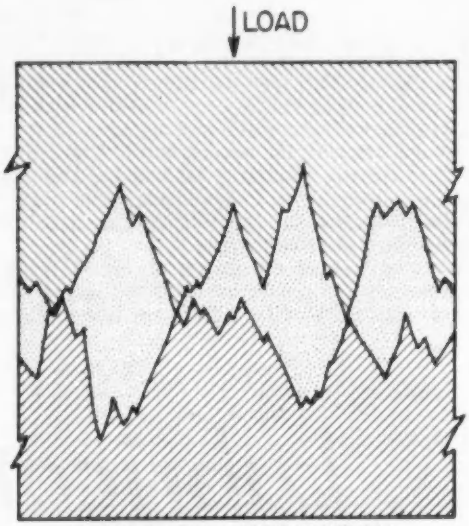
Hydrodynamic versus Boundary Lubrication



HYDRODYNAMIC LUBRICATION (THICK FILM)

Hydrodynamic Lubrication

Thick lubricant film prevents surface contact. The load is supported on the fluid film and the properties of the lubricant are important.



BOUNDARY LUBRICATION (THIN FILM)

Boundary Lubrication

Thin lubricant film allows surface asperities to touch through the film. The load is supported primarily by solid contact and the properties of the solids (particularly the surface films) are important. Pressure welding takes place at the points of contact, and the friction force is that force required to shear the welded junctions. Friction can be reduced by decreasing shear strength or increasing yield strength. By using a low-shear-strength film (with thickness as low as millionths of an inch) on hard-base materials, both conditions can be had. The load is supported through the film by the hard-base material, while shear occurs within the soft, thin film. Thus, a low-shear-strength contaminant will decrease the shear force, and reduce the welding, thereby reducing friction, wear, and surface damage.

ENGINEERS EARNESTLY CONSIDER HOW TO FLY PEOPLE AND CARGO SAFER, FASTER, CHEAPER.

Record Crowd Attends

Four-Day Aeronautic Meeting

SAE's three aviation Activities and its Production Activity joined hands in the star-studded four-day SAE Golden Anniversary Aeronautic Meeting. The first three days of technical sessions and Aircraft Engineering Display, April 18–20, were held at the Hotel Statler in New York. On April 21, the Aeronautic Production Forum part of the program was held at the neighboring Hotel McAlpin.

Attendance exceeded 2000, beating all previous records for SAE East Coast aeronautic gatherings. Engineers from all over this country and from Canada assembled to consider the 38 technical papers presented, hear seven round table discussions, and participate in the Production Forum's seven clinics.

Between events, the men browsed through the many booths of the Aircraft Engineering Display. Everywhere shop talk prevailed. Even lunch hours were devoted to timely talks by industry, government, and military leaders.

Only on Wednesday evening at a dinner-dance held in the Statler's Grand Ballroom did engineers lay aside technical concerns.

Each day of the three-day Aeronautic Meeting had its own theme, and simultaneous sessions made it possible to cover that theme in detail. Propulsion Day featured discussions ranging from piston engines to Poisson distributions. Air Transport Day topics ran from DC-3 replacements to deceleration of landing jet transports. Military Aviation Day subjects leaped from hovering helicopters to high-altitude missiles.

Theme for the Aeronautic Production Forum was "Meeting Competition Through More Efficient Production." The seven informal clinics, through the diversity of questions answered, proved you can boost efficiency of people and paperwork, as well as of production machinery.

This thorough airing of current aviation developments will be reflected in future issues of SAE Journal, which will abridge individually each paper and each secretary's report.

ON THE PAGES WHICH FOLLOW appear brief reports on the activities of each of the four days and highlights from each paper and organized discussion group.

Above: Midway through the all-day symposium on Packaging, five of the participants make plans for the afternoon portion. They are: **W. L. Hardy, H. E. Nietsch, J. T. Muller, Vincent Attalese,** and **R. L. Wiltse.**

Left above: Busy preprint counter sold 3648 preprints in three days.

Left below: **Frank E. Carroll, Jr.,** vice-president of the SAE Aircraft Powerplant Activity Committee presides at a program-planning session.

Propulsion Day

WITH all the emphasis on more powerful engines for jet fighters and faster, deadlier missiles, the aeronautic engineer is not trying to kill anyone. He is part of an essential industry—defense. The better he does his job and the stronger defense we build, the less likelihood we'll have to use it. ... This was the message Fred C. Crawford, chairman of the board of Thompson Products, Inc. delivered at the Propulsion Day luncheon, April 18.

A financially healthy, non-government-owned defense industry is just as basic to the welfare of American citizens as the food, clothing, and housing industries, Crawford emphasized. This defense industry must turn out a stream of new, better aircraft to replace the obsolescent models we must be scrapping.

The research expended in developing these new military aircraft is not wasted, Crawford pointed out. It's soon applied to commercial aircraft. When designers find ways to cut frontal resistance of the power unit in half, as they have over the last six or seven years, all aircraft benefit.

The technical sessions proved him right. Speakers describing new powerplants for military missions looked out on audiences scattered with commercial airline engineers looking for ways to apply new knowledge to civil use. They were vitally interested, for example, in how small turbine engines are smoothing wing boundary air. This trick could shorten landing and take-off runs of tomorrow's big airliners just as it will those of military cargo planes.

Propulsion Day sessions revealed the variety of sizes in which turbojets are now available. Some are in the 200–300-lb thrust class—just right for assisting the take-off of a small single-engine plane. Others are in the 10,000-lb-plus range and so much advanced over presently announced models that their capabilities could be only hinted at.

Highlights of the papers and round table discussions presented during Propulsion Day follow:

Power for Accessories

The ideal way to power aircraft accessories is by direct mechanical drive off the propulsion powerplant. But in practice, it can't be done in all cases. There just aren't enough places on a propulsion engine to put power take-off pads.

Probably the best solution to the accessory power problem is for the engine designer to provide as many power take-off locations as he can . . . and for the aircraft designer to resort to supplementary air turbines and auxiliary powerplants where he has to.

Accessory power requirements are mounting. So we'll see more and more use of auxiliary turbines and engines . . . from Round Table on Accessory Power Source—**George Sherman, Wright Air Development Center,** chairman

Turbojets for Missiles

Turbojets may be more attractive engines for missiles than either rockets or ramjets are. Turbojets are reliable, technically suitable for many missions, and—where they've already been developed for another purpose—relatively cheap.

It might even be desirable to provide for parallel development of a basic turbojet engine for both piloted and pilotless aircraft. This would give us an advanced missile engine early in the program when engine life was still too short for piloted aircraft. And

Above: **T. P. Wright** rises to make a point during a round table discussion. Leaders of the round table discussions were: George Sherman, USAF; F. W. Fink, Convair; L. O. Barnes, Allegheny Airlines; R. C. McGuire, Eastern Air Lines; Col. Norman Appold, USAF; J. D. Redding, Westinghouse Electric.

Fred C. Crawford, luncheon speaker greets his friend **Roy Hurley,** toastmaster

the missile program would provide a testing ground for piloted development.
. . . **J. D. Rogers, Westinghouse Electric Corp.,** "Turbojet Engines for Pilotless Aircraft, Present and Future"

Small Turbojets

Small turbojet engines can have high thrust/weight ratio and high thrust/frontal area ratio. They are simple and economical to develop and build. And they are rugged and reliable.

Most current small turbojets were created as expendable engines for small missiles and target drones. The same designs may be useful also for assisted take-off and boundary layer control.
. . . **A. T. Gregory, Fairchild Engine Division,** "Small Turbojet Engines—A Big Factor in Aviation"

T56 in C-130

Since January, Allison has been delivering T56 turboprops to the Air Force for installation in C-130 cargo transports. Cargo squadrons will get them late this year, it is expected. Allison plans to offer the engine for use in commercial airlines, too.
. . . **J. B. Wheatley, D. G. Zimmerman, and R. W. Hicks, Allison Division, GMC,** "The Allison T56 Turboprop Aircraft Engine"

"Supercharged" Turboprop

The British B.E. 25 is a turboprop consisting of a high-pressure compressor, combustion chamber, and high-pressure turbine, supercharged by a low-pressure compressor driven via a low-pressure turbine, by the exhaust from the high-pressure system. The propeller is geared to the low-pressure compressor.

The engine will deliver around 4000 hp at sea-level take-off and about twice that at 35,000 ft.
. . . **S. G. Hooker, The Bristol Aeroplane Co., Ltd.,** "The Supercharged Turbo Prop"

Bypass Turbojets

Bypass engines offer sufficient promise for improved overall efficiency of transport aircraft to warrant serious investigation. They have high efficiencies. Also, the reduced jet velocities cut down on engine noise.
. . . **G. F. Wislicenus, The Pennsylvania State University,** "Principles and Applications of Bypass Turbojet Engines"

How Much Air to Bypass?

By a generalized mathematical method, it's possible to calculate required air dilution ratio for a proposed bypass-type turbine engine design while it's still in the preliminary stages. The same analysis yields also the pressure ratio of the secondary air compressor and the expansion ratio of the turbine stages that drive the secondary air compressor, as well as temperatures and pressures all around the cycle.
. . . **Israel Katz, Cornell University,** "Optimum Flow Dilution in Ducted-Fan Engines"

Fail-Safe Turbine

Wherever possible we design the engine so that, if it fails, it will fail safe without addition of special devices. For example, in the turbine wheel of the Wright Turbo Compound engine, there is a small hole drilled in the blade root of four blades equally spaced about the wheel. At a predetermined overspeed, these four blades detach themselves and harmlessly strip off all the remaining blades from the wheel. We'd rather lose the blades occasionally this way than take a chance on a run-away turbine wheel or add a more complicated overspeed control.
. . . **W. G. Lundquist, Wright Aeronautical Division,** "Aircraft Powerplants—Present and Future"

Fragility

Fragility of a component or piece of equipment depends on its natural modes of vibration and the relative amplitudes. The natural modes may be determined by a vibration test and the amplitudes by a transient excitation—that is, a shock.
. . . **J. T. Muller, Sperry Gyroscope Co.,** "Testing for Instrument Fragility"

CONTINUED ON PAGE 102

Above: **Robert E. Johnson** presents plaque to **Igor I. Sikorsky** honoring him for his contributions to aviation and to SAE. Others visible are **Ralph Bell** who represented W. E. Beall, **A. T. Colwell,** and **Arthur Nutt.** Beall, Colwell, William Littlewood, Nutt, W. B. Stout and E. P. Warner also received plaques.

Left above: **William Littlewood** shows off gold satin vest and bow tie he wore to SAE Golden Anniversary Aviation Panel. Outfit was gift of Cleveland Section.

Left below: Secretary of Commerce **Sinclair Weeks** reaches for his speech notes as Toastmaster **Earl D. Johnson** introduces him at the luncheon.

Below: "Let's have your ticket," says the waiter to **Louis W. Davis.**

Air Transport Day

SOME of air transport's most pressing problems are ground problems, rather than altitude problems. That's why, for example, designers are working on improved anti-skid devices to shorten landing runs of big jet transports. Short-haul operators are demanding that their new transports take less time to service and load. Airline operators want assurance before they buy jet planes that jet noise won't alienate the neighbors. Air Transport Day emphasized these ideas.

There's definite hope that the noise problem will be solved, fortunately. Two experimenters reported on a prototype silencer they have already built for ground operation of jets. They even showed how the principle might be applied to a silencer that could be retracted when the jet was high enough not to disturb people on the ground.

One of these benefactors was John Tyler of Pratt & Whitney Aircraft, who with Edward C. Perry, Jr. of United Aircraft Corp.'s Research Division received the Wright Brothers Award for their paper on jet noise delivered at the SAE Aeronautic Meeting in New York a year ago. Harold W. Zipp presented the medals and checks at the luncheon. He substituted for Robert J. Woods, chairman of the Wright Board of Award.

Tyler and Perry received the congratulations of Secretary of Commerce Sinclair Weeks, who addressed the luncheon gathering. He commended them and the industry for assuming responsibility for public welfare. He further commended the airline industry for its participation in the Civil Reserve Air Fleet and the War Air Service Pattern plans. These programs aim to make best use of total air lift for military, war production, and civil defense needs in case of war, he explained.

Highlights of the papers and round table discussions presented during Air Transport Day follow:

Braking Jets

With runways costing a half million dollars or more per thousand feet, it pays us to find ways to shorten landing runs.

First step to take is to provide good

Above: **R. K. Rourke,** meetings vice-chairman for the Air Transport Activity, and **R. D. Speas,** vice-president, confer at Activity Committee meeting.

Below: Four of the 2000 members and guests who registered at the meeting wait to have name tags typed.

John Tyler (left) who has just received his Wright Brothers medal stands aside as **Harold W. Zipp,** member of the Board of Award, presents medal to Tyler's co-recipient, **Edward C. Perry, Jr.** Award was given for paper on jet noise.

brakes, and equip them with anti-skid devices that give the benefit of all the braking force available, right up to the skid point.

These measures will probably have to be supplemented with jet thrust reversers and possibly with drag chutes . . .

. . . from Round Table on Ground Deceleration of Aircraft —**R. C. McGuire, Eastern Air Lines, Inc.,** chairman

Short-Haul Transports

Speed in the air doesn't mean much on short trips. For example, Mohawk Airlines saves only about ½ min on its hops by using Convair 240's instead of DC-3's. What is important is speed of passenger loading and airplane servicing.

If we're ever to have a DC-3 replacement, civil operators will have to join with military operators in planning for it. Probably they'll find it easier to design to CAA regulations and modify to military specs than vice versa . . .

. . . from Round Table on Short-Haul Transports—**L. O. Barnes, Allegheny Airlines,** chairman

Sound Attenuation

When sound waves are transmitted through a gaseous medium, there is a loss of sound energy through direct conversion to heat. In dry air this effect is minor. But when even small quantities of water vapor are present the effect may be significant, particularly at the higher frequencies.

. . . **K. D. Swartzel, consultant,** and **Murray Kamrass, Cornell Aeronautical Laboratory,** "Evaluation of the Noise Field Around Jet-Powered Aircraft"

Ground Silencer

Our ground silencer consists primarily of a long perforated sheet metal tube attached to the nozzle of the jet engine. The end of the tube is closed with a cone of the same perforated sheet. Holes are 0.085 in. in diameter, three diameters apart. When the engine exhausts into this tube, the tube acts as a diffuser.

Since the gases are exhausted mostly in radial directions, the thrust is lost. However, for ground runs this does not matter.

The tiny holes break the exhaust into tiny jets generating high frequency noise. The "silencing" is due to the fact that the atmosphere attenuates high frequency sound much more effectively than low frequency sound.

. . . **John Tyler and George Towle, Pratt & Whitney Aircraft,** "A Jet Exhaust Silencer"

Tolerable Noise

There will be negligible risk of permanent hearing loss, under continuous exposure for a life time, if the noise is of a steady character, and if the sound pressure level at frequencies above 200 cps is less than 95 db in any octave band. Greater levels can be tolerated at lower frequencies. Overall sound levels as high as 110 db may be safe, depending on the spectrum.

. . . **R. H. Bolt, Massachusetts Institute of Technology,** "Human Engineering Aspects of Aviation Noise Control"

CONTINUED ON PAGE 106

Above left: **Ray Kelly** and **Frank Tobin** enjoy the view.

Above right: Heading the table as the Aircraft Activity Committee plans ahead are **W. B. Bergen,** meetings vice-chairman and **J. D. Redding,** vice-president.

Below: General Chairman of the Meeting **R. E. Johnson** dines with **Lt.-Gen. Joseph Smith,** commander of the Military Air Transport Service, and **Frank Piasecki.**

Above: **Gen. Benjamin W. Chidlaw,** luncheon speaker, chats with **Mundy I. Peale,** who was toastmaster.

Military Aviation Day

THE military services need a complete family of up-to-date aircraft ranging from fighters and interceptors down through several sizes of cargo transports to helicopters. The lesson of Military Aviation Day was that we must push development of both service and combat types.

Speaking of the Air Forces' current rocket-firing fighter-interceptors, luncheon speaker Gen. Benjamin W. Chidlaw said, "Our planes have the capability of coming on target at 1000 ft or more per sec. Rate of closure is so fast that the plane must be lined up on the objective and combat action started as much as 30 miles off."

Even in cargo planes, speeds are noticeably on the rise, thanks to turboprops, it was reported. USAF is trying out the Allison T56 in the Convair 340 and experimenting with replacing piston engines of other current transports with turboprops.

The ability of boundary layer control devices to augment wing lift at low speeds and thereby shorten take-off and landing runs is impressing both the Air Force and the Navy. The former is applying it experimentally to cargo planes, and the latter to carrier-based planes, speakers revealed.

But for really tight spots, you can't beat the helicopter, said a Marine who spoke from front-line Korean experience. He and his military colleagues foresaw future landing assaults being made by helicopter-borne troops. Advantages of helicopters are that they're much faster than boats—and they fly low enough to escape radar detection by the enemy.

Highlights of the papers and round table discussions presented during Military Aviation Day follow:

More Mobility Needed

History teaches us that the more highly industrialized a nation is, the better are its chances for military victory. History also teaches us that unless combat forces can be supplied with materiel, even highly industrialized nations can be defeated. The lesson is that we must provide our fighting forces with mobility on a global scale, regardless of cost. We must have a well-balanced family of air transports, suited to the total air lift job. . . . **W. R. Rhoads, Lockheed Aircraft Corp.,** "Trends in Military Cargo Transport"

C-123 Gets Boundary Layer Control

For experimental purposes, Stroukoff Aircraft has equipped a C-123 assault-type cargo airplane with boundary layer control. Purpose is to shorten landing and take-off runs. To control the boundary layer, air is sucked in over the inboard flaps and blown out over the outboard flaps and drooped ailerons. Power for suction and blowing comes from a tiny Aspin

Couple above is Met Section Chairman **Lewis F. Moody, Jr.** and **Mrs. Moody.**

Dancers made good use of the Grand Ballroom's big floor. Corsages and boutonnieres were distributed (left above) by stewardesses from 11 airlines.

II ducted fan housed in the wing.
. . . **Joseph Flatt, USAF,** "Some Experiments in the Application of Boundary Layer Control"

More Lift for the F9F

Boundary-layer control applied experimentally to the Grumman F9F-4 Panther shortened landing and take-off runs as much as a 25% increase in wing area would. Weight penalty for the installation was only 50 lb. Source of pumping energy was the jet propulsion engine.
. . . **J. S. Attinello, Navy Bureau of Aeronautics,** "Wing Lift Augmentation Methods for the Improvement of the Low Speed Performance of High Speed Aircraft"

JP-4 Looks Best

The turbine fuel which represents the best overall performance compromise is heart-cut JP-4—or roughly the hydrocarbons boiling between 250 and 400 F. JP-4 weighs less per therm than kerosene, more readily meets freezing point requirements, and burns better.

Some argue, however, that JP-4 is not quite so safe to handle as kerosene. And there's no question that airlines using JP-4, or any other middle distillate, will have to compete with motor fuel users for the product.
. . . **H. E. Alquist and R. M. Schirmer, Phillips Petroleum Co.,** "A Critical Survey of Commercial Turbine Fuels"

Turbine Lubes

Synthetic gas turbine lubricants are, for the most part, giving satisfactory service. USAF does find, however, that certain lubricants coke in certain applications. This necessitates short drain periods and frequent cleaning of oil filters.

Film strength is another problem. If we could get oils of higher film strength, we could raise operating limits of some turboprops.
. . . **T. F. Davidson, T. P. Cooley, and J. H. Way, Wright Air Development Center,** "Air Force Experience with Synthetic Gas Turbine Lubricants"

Heliports

Heliports are like superhighways—everybody wants them until they find out where they are going to be. Frequently the city dump becomes the heliport.

Here are some of the criteria that ideally should be considered: Proximity to traffic-generating centers, nearness to post office, elevation, obstruction clearance, noise nuisance, practicability of providing refueling facilities. Most of the area involved in a heliport is required to take care of engine failure on take-off. It needn't all be hard surface—could even be barges on water.
. . . **Horace Brock, New York Airways, Inc.,** "On the Location of Heliports"

CONTINUED ON PAGE 106

TOASTMASTER AND FORUM SPONSOR George F. Chapline (center) spent a little time just before the formal luncheon program with his friends T. P. Pike (right), Assistant Secretary of Defense, Supply and Logistics, who was the principal speaker, and Maj.-Gen. L. P. Whitten, Commander, Middletown Air Materiel Area.

Production Forums

SOME 500 manufacturing men spent the day at the Aeronautic Production Forum handling successfully the problems that plague them at their own plants.

They communicated ideas, swapped shop methods, and reached agreement on improved ways of fabricating aeronautical material.

Men who are suppliers and those who are prime contractors reached better understandings on mutual inspection and scheduling problems. Military and government officials sat through all panel sessions and helped throw light on their own position, came away with a fuller appreciation of the contractor's problems.

Typical of clarifications that emerged was indication that the Department of Defense is being run with businesslike efficiency. T. P. Pike, Assistant Secretary of Defense, Supply and Logistics, showed that a standardization program now under way is yielding extensive economies in the military branches. For instance, the 3,700,000 items in the military supply system are being reduced to 2,250,000 . . .685 types of paper forms were cut to 27 . . . military storage space released has a replacement cost of $123,000,000.

Despite these and other economies now in the works, said Pike, "Our country today has a stronger military defense position than ever before in peacetime."

Highlights of panel reports follow:

Rumor on the Wing

To see whether rumors travel faster than company communications, one executive conducted an experiment. On the way into the plant one morning, he stopped and said to the doorman, "Did you hear that we're merging with the Frammis Corp.?"

He then walked to his office at the other end of the plant. Exactly 7½ min later, a supervisor stuck his head in the executive's office and asked: "Say boss, what's this I hear about us merging with Frammis?" . . .

. . . from panel **"Techniques for Improving Factory Communications."**

Automation Needs

Machine tool builders are being asked by users to build preventive maintenance features into automated equipment. An example is an automatic means to compensate for dressing grinding wheels to hold size. Users would also like to have devices that take machined parts off the end of a line and lay them in a tray or bin instead of dumping them in. . . .

. . . from panel **"Automation and Its Effect on Manufacturing Methods."**

Electronic Mayhem

Guided missiles are said to be committing "electronic suicide." That's because they operate in difficult environment, develop corrosive vapors,

and wreak havoc with sensitive electronic devices. The interaction of new alloys and plastics is behind this corrosion.

In an airplane, the pilot can compensate for most electronic failures. A guided missile can't tolerate them. That's why the industry is talking about electronic components with a 20-year life. . .

. . . from panel **"Problems in the Manufacture of Electronics Equipment."**

People and Processes

There's much to be gained from informality in the shop. You'll get much better results if you bring in both the supervisors and operators on the planning and completion promises for various jobs.

Look to electrical discharge machining as a means of cutting your tool room costs. This method can sharpen carbide tools two to three times faster than abrasive methods. . . .

. . . from panel **"The Effect of a Cost-Reduction Program on Tooling."**

The Paper Battle

Eliminating paperwork will go a long way toward launching a cost-cutting program. Investigation will often show that there's duplicate reporting, growing out of lack of coordination.

Most effective are short reports. A plant manager should get no more than one report from the people reporting to him. . . .

. . . from panel **"Getting Maximum Results from a Cost Reduction Program."**

How Much Inspection

The value of in-process inspection depends on the part being made. It's not necessary for a small group of parts made for say experimental purposes. However, if a part is to be made in large quantities, in-process inspection is essential to prevent extensive losses due to an error early in the processing.

Responsibility for quality rests with anyone who has anything to do with processing the part. Of course, the operator makes the part right or wrong in the final analysis. Inspection interprets standards and specifications to determine whether the part is acceptable. . .

. . . from panel **"Taking Dollars out of Quality Control without Losing Quality."**

Management Keeps Tabs

Decision-making on engineering changes is going to higher management echelons. It's being forced by keener competition, since the extent of engineering changes may heavily affect the profit dollar. . .

. . . from panel **"Engineering Changes in a Competitive Market."**

FORUM CHAIRMAN A. B. Hegner (seated, second from left) briefed his panel leaders just before the Forum got under way. The leaders and the panels they led are: (seated, left to right) M. F. McCammon, Eclipse-Pioneer Division, Bendix Aviation Corp., "Engineering Changes in a Competitive Market;" C. P. Urbon, General Electric Co., "The Effect of a Cost-Reduction Program on Tooling;" W. B. Bergen, The Glenn L. Martin Co., "Techniques for Improving Factory Communications;" (standing, left to right) W. A. Ehrlich, The Bullard Co., "Automation and Its Effects on Manufacturing Methods," E. D. Bryant, Fairchild Engine Division, "Taking Dollars out of Quality Control without Losing Quality;" E. M. Wise, International Nickel Co., "Problems in the Manufacture of Electronics Equipment;" J. V. Miccio, Wright Aeronautical, "Getting Maximum Results from a Cost Reduction Program."

Engineering Display

Ever-Popular Engineering Display Draws Stream of Men to View the Latest Wares of 47 Exhibitors

COMPANIES REPRESENTED at the Engineering Display included the following—

Metal Finishing Service . . . Lear, Inc. . . . American Steel & Wire Division, United States Steel Corp. . . . Rosan, Inc. . . . Stratos Division, Fairchild Engine & Airplane Corp. . . . Wyman-Gordon Co. . . . Hi-Shear Rivet Tool Co. . . . New York Air Brake Co. . . . Boeing Airplane Co. . . . Aeronautical Service Engineering . . . Lord Mfg. Co. . . . Sunstrand Aviation Division, Sundstrand Machine Tool Co. . . . Rohr Aircraft Corp. . . . General Controls Co. . . . Belock Instrument Corp. . . . Vickers, Inc. . . . Minneapolis Honeywell Regulator Co. . . . American Chemical Paint Co. . . .

Acushnet Process Co. . . . Bland Burner Co. . . . Control Products, Inc. . . . Curtiss-Wright Corp. . . . Westinghouse Electric Corp. . . . General Electric Co. . . . Bodnar Industries, Inc. . . . Mycalex Corp. of America . . . AiResearch Mfg. Co. . . . Scovill Mfg. Co. . . . Thermo Electric Co., Inc. . . . Ryan Aeronautical Co. . . . United Aircraft Products, Inc.

Lebanon Steel Foundry . . . Al-Fin Division, Fairchild Engine & Airplane Corp. . . . Industrial Sound Control, Inc. . . . Liberty Tool & Machine Co. . . . O & M Machine Co., Inc. . . . Barber-Colman Co. . . . Aeroproducts Operations, Allison Division, GMC . . . Saginaw Steering Gear Division, GMC . . . Fairchild Engine Division, Fairchild Engine & Airplane Corp. . . . Fasteners, Inc. . . . Indiana Gear Works, Inc. . . . Sun Electric Corp. . . . Elastic Stop Nut Corp. of America . . . Hamilton Standard Division, United Aircraft Corp. . . . Jack & Heintz, Inc. . . . Honeycomb Co. of America, Inc.

U.S. Naval Engineering Experiment Station Investigates

Turbosupercharging The 2–Stroke Diesel Engine

H. T. Smith,
Tracked Vehicle Test and Experimental Unit, Marine Corps Base, Camp Pendleton, Calif.

Based on paper "A High-Supercharge 2-Stroke Diesel Investigation" presented at the SAE National Diesel Engine Meeting, Cleveland, Oct. 27, 1954.

PART I Laboratory tests with a GM 1-71 2-stroke diesel engine prove turbosupercharging is feasible

IF a 2-stroke cycle diesel engine is compounded with a turbosupercharger, power output can be considerably increased. This was indicated by recent experiments at the U. S. Naval Engineering Experiment Station, in which the effect of a turbosupercharger on a 2-stroke cycle diesel test engine was simulated under controlled conditions. Complete acceptance of a compound-diesel engine must await the development of a more efficient turbosupercharger that is properly matched to the cylinder section.

Turbosupercharger is Simulated

A modified General Motors Model 1-71 diesel engine was used during the test. It was supercharged from an external air supply to 40 psig manifold pressure at 125 to 300 F inlet air temperatures, and operated at 125 to 200 psi bmep power levels. Back pressure was maintained at 30 psig to simulate a turbosupercharger load.

Steel spacer plates installed between the cylinder block and cylinder head made it possible to operate the engine at 6, 8, and 10/1 compression ratios.

A specially-designed, unit-type fuel injector increased fuel injection capacity to 250 cu mm per stroke, as compared with 60 to 90 cu mm used in standard engines.

As shown in the schematic diagram of the test installation, Fig. 1, shop air was piped to the engine, replacing the regular scavenge air blower. A separate motor-driven pump circulated the diesel fuel from the day tank to the injector and return. Standard 50 cetane, N. S. 7-02e Navy diesel fuel was used.

Another motor-driven pump circulated fresh water through the engine's water jacket and heat exchanger.

800 Test Runs Were Recorded

After operating the engine with its standard injector and at nominal 16/1 compression ratio to get comparative data, it was converted to a 6/1 compression ratio and a high capacity fuel injector installed. An arbitrary 200 psi bmep was set as a goal for the lower-compression-ratio, high-supercharged

This is Part I of a two-part article on **Turbosupercharging The 2-Stroke Diesel Engine.** Part II, describing turbocharging the GM Model 16-278A diesel engine, will appear next month.

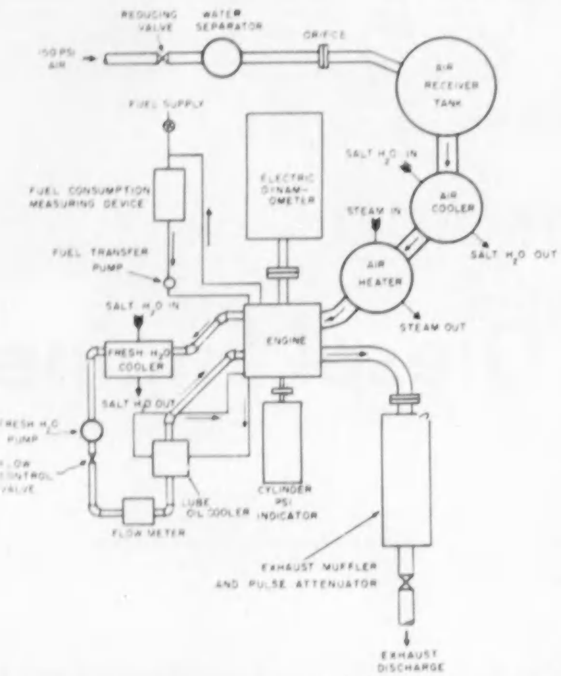


Fig. 1—This schematic diagram shows the test installation with which turbosupercharger operation on a 2-stroke diesel engine was simulated.

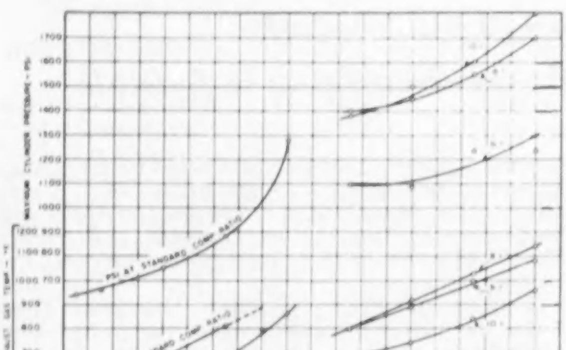


Fig. 2—Performance characteristics of the GM 1-71 diesel engine at 1800 rpm under optimum conditions. For comparison purposes, corresponding data for the 10 to 100 psi bmep operation of the standard 16/1 compression ratio engine are included.

test conditions. A total of 800 runs under various compression ratios, speeds, and bmep power outputs was made. The results are shown in Fig. 2.

Lowest specific fuel consumption was obtained during the 8/1 compression ratio operation. Brake specific fuel consumption ranged from 0.43 to 0.47 lb/bhp-hr for the 125 to 200 psi bmep operation. Maximum exhaust gas temperature was 1135 F and peak cylinder combustion pressure was 1700 psi. Cylinder compression pressures, obtained by extrapolating the 125 psi bmep cylinder pressure diagrams to top dead center were 740 psig.

Beginning of fuel injection was at 13.9 deg btc for the 125 psi bmep load and automatically advanced by fuel injector helix angle to 24.4 deg btc for the 200 psi bmep load level. The exhaust valves were slightly retarded to open at 77 deg bbc.

A photographic reproduction of a pressure crank angle-cylinder pressure diagram is shown in Fig. 3. A rapid rate of pressure rise following ignition of the charge and considerable scattering of the points near the peak of the pressure curve is evident. The high capacity and the rate of fuel delivery by the particular fuel injector, plus apparent cycle-to-cycle variations in the amount of fuel injected, were contributory factors to the shape of the combustion section of the diagram. Improved combustion characteristics, with a lower rate of pressure rise and lower peak cylinder pressures, would appear possible if the fuel injector components were redesigned to soften the rate of fuel injection.

The results obtained in this test project show that a high-output, compact, fairly-efficient powerplant is feasible with some development of parts for reliable operation. The 200-psi bmep goal was obtained with satisfactory operating temperatures, pressures, and fuel economy. At that load level, at 1800 rpm, the engine developed 0.9 bhp per cu in. of displacement and delivered more than enough energy in the exhaust gas to satisfy its intake manifold requirement. A well-balanced multicylinder engine of comparable bore and stroke should be capable of operating at up to 2500 rpm (2080 fpm piston speed) at the 200 psi bmep power level. The specific output on such a basis would be approximately 1.26 bhp per cu in. displacement, or 90 bhp per cylinder.

A compound or highly-supercharged diesel engine operating in the range of an 8/1 cylinder compres-

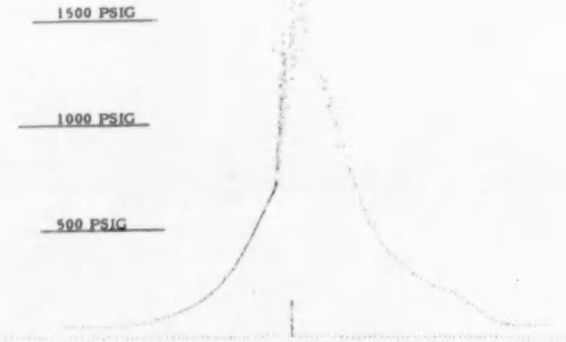


Fig. 3—Pressure crank angle versus cylinder pressure. These data were obtained from a modified GM 1-71 diesel engine, 8/1 compression ratio, 200 psi bmep.

sion ratio would require auxiliary methods to start the engine, since the temperature of the air at the end of the compression stroke would not be high enough to autoignite the fuel, unless the intake manifold were pressure charged and preheated to its normal operating level while the engine was being cranked.

One way of accomplishing that purpose is to add a combustion chamber and suitable valves to the turbosupercharger so that it could operate at full-rated speed as a gas turbine while the diesel engine was being cranked. Some of the heated, compressed air from the compressor section of the turbosupercharger would be delivered to the intake manifold of the diesel engine which would then start readily when cranked. It might also be necessary to operate the auxiliary combustion chamber when the diesel is operating at light loads or idle. At that time the available energy in the exhaust gas may be inadequate to operate the turbosupercharger at a high enough speed to pressurize properly the intake manifold of the diesel.

Another means for starting and light-load operation would be a provision for changing the volume of the combustion space in accordance with the ignition temperature requirement. A controllable stroke, a displacer-type cylinder head, or an auxiliary combustion space which could be opened via a valve are suggested.

(Paper on which this abridgment is based is available in full in multilith form from SAE Special Publications Department. Price: 35¢ to members, 60¢ to nonmembers.)

Based on discussion . . .

E. R. Klinge, Continental Aviation and Engineering Corp.

Although it appears that tremendous power increases are possible by turbocharging or compounding, the ultimate value must be assessed in terms of what happens to power package weight, bulk, durability, and cost per horsepower increase.

Hans Bohuslav, Miehle-Dexter Supercharger Division, Dexter-Folder Co.

One of the main problems with 2-cycle engine turbocharging is supplying sufficient scavenge air for starting and idling. A small, rotary, positive blower, driven by the engine through an automatic clutch, provides an uncomplicated method. It need be only a fraction of the capacity of one normally used to supply scavenging air because only a fraction of the air available in the cylinder is used up for combustion during starting and idling. It could discharge directly into the turbocharger inlet which is closed off from the atmosphere during the auxiliary blower's operation. When the turbocharger reaches sufficient speed, this blower would automatically disconnect.

A heater could be provided to increase air temperature for starting—especially when low compression ratios are used. After starting, the heater can be shut off.

Rudolph Birmann, De Laval Steam Turbine Co.

Engine output equally as great or even greater than that described in the above article could have been achieved under conditions of much lower thermal loading and only slightly greater mechanical loading—and therefore, less detrimental to engine durability. It is possible, if inlet manifold pressures and temperatures, exhaust back pressure, valve and injection timing, and other operating conditions are properly selected. This would have involved cooling the precompressed air supplied to the engine. It also would have resulted in improved specific fuel consumption.

In compounding engines, the turbocharger must be matched to the engine. In the GM 1-71, the engine flow resistance is high. This is undesirable for turbocharging. It could be reduced by closing the exhaust valves after the intake ports are closed and lengthening the period during which the exhaust valve is open.

J. T. Pearsall, Bureau of Ships, Navy Department

The Bureau of Ships contracted with Lanova Corp. to turbocharge a GM Model 6-71 engine as a result of the stimulus from the Annapolis experiments.

The engine was arranged with its Roots blower removed and installed as a motor-driven unit in series with, and after, the turbocharger. Thus, the blower operated with no pressure differential across it and the engine was truly supercharged. The Roots blower could be used to help supply air at low loads and speeds where the engine and turbo could not otherwise be self-sustaining.

Power output and fuel economy were considerably improved.

The Engineering Experiment Station is doing further work at higher engine speeds and with a larger turbosupercharger.

V. C. Reddy, Detroit Diesel Engine Division, General Motors Corp.

Turbosupercharging is very effective on a 2-cycle engine. Our tests achieved a maximum output of 426 bhp at 2600 rpm; that is, 1 bhp per cu in. displacement. No special equipment was necessary to start the turbocharger test because the same compression ratio was used as in production engines.

A mechanically-driven Roots blower in series with the turbocharger is necessary to contribute to the air box pressure. When a turboblower is developed with an overall efficiency of 65 to 70%, the mechanically-driven blower can be dispensed with.

The degree of supercharging proposed in the above article is not practical at present. Turbochargers with the 3.5/1 pressure ratio necessary to produce the 40 psi air box pressure are not available commercially in the small sizes required by 425 cu in. displacement engines. However, a bmep of 160 psi on a 4-cycle basis, can be obtained with commercially available turbochargers.

P. H. Schweitzer, The Pennsylvania State University

In 1945 we ran somewhat similar tests, highly supercharging a GM 71 engine. I refer you to SAE Quarterly Transactions, October, 1949, for the results, which are not very dissimilar from the above. I agree that a high specific output powerplant could be designed from the GM 71 engine, if a compact, well-matched turbocharging unit were added to it. For starting, it might be best to retain the Roots blower and add an ether starter to the intake manifold.

Sixth Annual Earthmoving Industry Conference

—reported by W. J. Lux

Good Ideas Can Move The Earth

BANQUET SPEAKER P. D. Bagwell, Michigan State College professor, spoke on "The Power of Ideas."

THE 1955 Earthmoving Industry Conference in Peoria, Illinois, April 13 and 14, illustrates the growth of small ideas into a success. A record 1157 contractors, manufacturers, designers, operators, salesmen, and administrators attended the Conference, which is operated by the SAE Central Illinois Section. The Earthmoving Industry, by careful attention to small details as well as large problems, is doing its share to make a better world. It will continue to grow and contribute to progress.

SAE President C. G. A. Rosen and banquet speaker P. D. Bagwell agree that "there is no limit" to the future of the Earthmoving Industry. Past achievements serve only to indicate the vast potentialities which lie ahead for the equipment manufacturer, the designer, the salesman, and the contractor in this great industry.

Professor Bagwell, Head of the Department of Communication Skills at Michigan State College, told his banquet audience that progress and development have always begun with ideas. Ideas have been basic forces in the development of what is popularly known as "the American Way".

The American citizen in 1955 has the greatest wealth of all kinds that any known civilization has ever produced. He is unsurpassed in capital and material wealth. His field of knowledge and understanding is much wider than that of his ancestors. His political privileges (and responsibilities) have developed through many successive stages of refinement. Science has given him control of many forces of nature, and each day new miracles are harnessed to make his life better.

Economic and business forecasts indicate that the future will continue to bring increased blessings of wealth and happiness.

The Earthmoving Industry has grown and flourished because its energies are channeled toward a better life for others. Mr. Rosen in his keynote address pointed out

BEHIND THE SAE Golden Anniversary banner is Randall Roman, Chairman, Central Illinois Section. On-looker at left is C. G. A. Rosen, SAE's President; at right is J. W. Sydnor, Earthmoving Conference Chairman. (Below) SAE members and guests register for the two-day session which took place at the Hotel Pere Marquette, Peoria, Illinois.

that the earthmoving industry has grown from the prehistoric invention of the wheel to a present industry that consumed over one billion dollars of off-the-highway earthmoving equipment last year. The internal combustion engine was a major "idea" that grew and became a part of the earthmoving industry, as well as a part of the transportation industry. In 1912, a conventional 200-hp diesel engine had a 12-in. bore, 18-in. stroke, and four cylinders; was 10 ft high, 14 ft long; and weighed 40 tons. Our present engines develop more power with a fraction of the size, weight, and cost.

Larger production of automobiles and trucks is rapidly making our highway network inadequate. Larger and faster earthmoving equipment will help solve the highway problem. Ideas sparked by the creativeness of men in the industry will provide the tools for bigger and better highways at lower cost. Vehicles of 1000 hp with powerplants consisting of

H. S. EBERHARD, President of Caterpillar Tractor Co. (left) introduces keynote speaker, C. G. A. Rosen. Eberhard saw Earthmoving Conference growth as a result of the contributions SAE members have made, and the need for better earthmoving machinery. He cited Rosen as "a distinguished engineer and speaker on technical subjects . . . equally at home in other fields . . . one of the founders of the CIMTC . . . a guiding influence in the first earthmoving industry conference held here in 1950." "Art," he said, "has provided stimulation and inspiration to a great many engineers."

improved turbo-charged diesels, gas turbines, and atomic power are in the picture. Truly there is no limit in the future.

Modern highways have become highly developed installations. J. G. McKay described "Modern Highway Planning" as a complicated, detailed operation requiring much careful study and thinking. Because it involves many hundreds of millions of dollars, a highway plan must be correct; such plans are extremely costly to change. N. L. Teer, Jr. described similar complications in "Organizing and Operating a Turnpike Job". The size and type of operations on a turnpike job call for new equipment and new methods.

"Construction Power in Military Operations" has become a prime consideration in both combat and peaceful activities. Brig.-Gen. Howard Ker told the Conference that future modes of warfare will provide more and larger problems which earthmoving equipment will be called to handle.

Salesmen are an important part of the earthmoving team, as they are in any business. Frank Skidmore presented the salesman's view of earthmoving machinery. He is vitally interested in its design, its manufacture, and its ability to do good work for his customers.

Individual and detailed problems are in good hands. D. O. Meek described "Rotary Air Compressors" and their qualifications. R. C. Kerr listed the factors in "The Selection of Pneumatic Tires for Off-Road Vehicles". "Earthmoving Compaction Methods and Results" were summarized by Consulting Engineer B. K. Hough. Power shovels are important pieces of equipment in almost any contracting venture, and their use for excavation and material handling was discussed by Q. J. Winsor.

Highlights of the papers presented at the two-day conference follow:

Twelve years of research and development have resulted in a new positive displacement rotary air compressor. The absence of reciprocating parts allows smooth operation at higher speeds than are practical with the piston-type compressor.

The 100 psi, two-stage compressor has an interesting cooling method. Oil is injected into the air during the compression cycle. The oil is later separated from the air, cooled by water, filtered, and returned to repeat the cooling cycle. In a compressor driven by a gasoline or diesel engine, jacket

WEDNESDAY MORNING session Technical Chairman G. P. Koch shows speaker D. O. Meek his spot on the Conference program.

WEDNESDAY AFTERNOON speakers Q. J. Winsor (left) and R. C. Kerr (right) look over shoulders of Technical Chairman D. K. Heiple.

These committee members administered the various details of the Sixth Annual Earthmoving Industry Conference.

J. W. Sydnor—General Chairman	**M. M. Gilbert**—Publicity Chairman
H. H. Piper—Secretary	**J. T. Liggett**—Finance Chairman
L. C. Bailey—Treasurer	**W. J. McCulla**—Arrangements Chairman
R. E. Mayo—Program Chairman	

These technical chairmen introduced the speakers and led discussions.

G. P. Koch—Allis-Chalmers Mfg. Co.	**N. L. Snowden**—Caterpillar Tractor Co.
D. K. Heiple—LeTourneau Westinghouse Co.	**R. H. Hunger**—Caterpillar Tractor Co.

FOOD FOR THOUGHT and digestion crossed the tables at the banquet. Randall Roman was toastmaster.

water can be used to cool the compressor oil. . .
. . . **D. O. Meek, Gardner-Denver Co.,** "Rotary Air Compressors."

Turnpikes are different in both size and character than other common types of construction and earthmoving jobs. As different problems, they require handling not normally applied to other jobs, in addition to all the planning and care used by any successful contractor. Because turnpike jobs are in general of extremely large proportion, more than one contractor will be involved in the planning, bidding, and eventual consummation of the project.

The contractor interested in a turnpike job must possess as much detailed information as possible on the project, as he must in any undertaking. However, because of the scope of a turnpike undertaking, the contractor is in the unique position of having to compete with other contractors for a position where he will have to work in close cooperation with the same contractors. The cost estimation and preparing of bids have thus been made more complicated.
. . . **N. L. Teer, Jr., Nello L. Teer Co.,** "Organizing and Operating a Turnpike Job."

The salesman must highlight such features as long life, easy service, parts availability, and high efficiency. He wants a product and an organization which guarantees those qualities. He will also work hard to establish a good reputation for his product, so he is an invaluable member of the engineering-production-merchandising team.

How much work a machine will do determines how much money the contractor will make. The salesman must be able to show his prospect how he can operate more efficiently and earn more profit. To do this, he needs all of the information and help he can get from the designers, the shop, and his own sales organization. . .
. . . **Frank Skidmore, Associated Equipment Distributors,** "What The Salesman Wants to Sell in Earthmoving Equipment."

Compaction methods differ according to the soil type. Plastic soils may best be worked by tamping and rolling, while for granular soils, other methods such as vibration are effective. Water is one of

THURSDAY MORNING speakers: (Left to right) Technical Chairman N. L. Snowden, F. Skidmore, Brig.-Gen. Howard Ker, B. K. Hough.

THURSDAY AFTERNOON speakers J. G. McKay (right) and N. L. Teer, Jr. (center) chat while Technical Chairman R. H. Hunger looks on.

The Future of the Earthmoving Industry

—Highlights from **C. G. A. Rosen's** Keynote Address to the Sixth SAE Earthmoving Industry Conference, Peoria, Illinois

- **In a few years** powerplants of 1000 hp will be required to move larger, faster earthmoving equipment.
- **Turbosupercharging** the 4-cycle and 2-cycle engine to get 50 or even 100 lb boost will be possible.
- **Gas turbine engines** for earthmovers will produce even higher horsepower in smaller packages. By 1975 there could be 62,000,000 automotive gas turbines on the road.
- **Titanium,** ceramics, cemented carbides and other pure metals and alloys will be used in future earthmoving machinery.
- **Transmission units** with infinite speed variations will reduce operating costs.
- **Steam** may be used in future powerplants to achieve high efficiency of energy conversion and provide an infinite torque arrangement without expensive transmission devices.
- **Bigger and lower** pressure tires, greater flexibility of tracks, improved controls, and operator comfort loom large in the future.
- **New methods** of slicing, scraping, loading, and carting earth will be adopted.
- **Earthmoving equipment** powered by atomic energy will eventually be practical when the shielding problem is solved.

the oldest methods of compacting certain soils, and is still used on occasion. Shock, such as from explosives, is used in special applications.

Vibratory compacting equipment is perhaps most interesting and most promising for future development. Vibration is designed into a variety of equipment, both in roller and sled form, and is also used in special applications. The best frequency for vibratory equipment depends on the soil type being worked. Chemical soil treatment also offers promise in future compaction techniques. . .
. . . **B. K. Hough, Cornell University,** "Earth Compaction Methods and Results."

National defense is the biggest business in the country today, and the Earthmoving Industry plays a vital role in that business. The U. S. Army Corps of Engineers provides a multitude of services during peacetime. Its operations include construction, improvement, and maintenance of harbors and canals, flood control, and other disaster prevention work, and equipment and materials development work.

Many of these jobs require the use of earthmoving equipment under conditions which demand the best performance possible.

The dispersion of facilities, made necessary by future methods of combat, will increase the need for top-performing earthmoving equipment many times. Arctic operations will be of prime importance in the future and will give rise to many new challenges. Ground facilities for larger and faster aircraft must keep pace. . .
. . . **Brig.-Gen. Howard Ker, U. S. Army,** "Construction Power in Military Operations."

The off-road tire has now been in use for twenty years, and billions of tire miles have been accumulated. The off-road or flotation tire is a thin walled, subdued tread tire with a circular profile. It will withstand a much greater degree of flexing than heavier highway tires, and therefore it operates with a wide bulge and a correspondingly greater ground contact area. This, in turn, results in lower ground bearing pressure. . .
. . . **R. C. Kerr, Arabian American Oil Co.,** "The Selection of Pneumatic Tires for Off-Road Vehicles."

Power shovel design is complicated by the wide range of "front end" equipment which may be used. A basic unit may be equipped with a crane boom, dragline, clamshell, dipper stick shovel, back hoe, or many others of a large list. Each of these components does a different type of work, and each imposes different modes and amounts of loading on the basic unit. The basic unit must therefore be designed to use any of the various pieces of "front end" equipment.

Crawler and rubber tired undercarriages must be carefully designed to give a good balance between stability and shovel working range. Transportation from job to job must also be considered in the shovel design. Shovels are adaptable to an extremely wide range of jobs. A shovel can move many kinds of materials; it can work on many kinds of surfaces; and it can work in restricted areas.
. . . **Q. J. Winsor, Thew Shovel Co.,** "Power Shovels for Excavation and Material Handling."

The advent of superhighways, turnpikes, and limit-access roads have added new problems to the highway planner's daily work. He is not concerned only with a medium or light duty highway from point A to point B. He now must plan for long stretches of superhighways of latest design to carry large numbers of passenger vehicles and heavy trucks at high speeds. The purchase of large areas of right-of-way poses complicated problems for the agency supervising the highway project.
. . . **J. G. McKay, Ohio Turnpike Commission,** "Modern Highway Planning."

TECHNICAL COMMITTEE *Progress*

International Lighting Men Meet in Detroit

TWENTY-ONE European lighting engineers met in Detroit April 26–30 with American engineers on an International Standards Organization program. Purpose of the four-day get-together was to discuss uniform international lighting standards. Special emphasis was given to vehicle headlamp lighting. Discussions were based on extensive cooperative tests comparing the improved sealed beam with representative European head lighting practice.

The Europeans were met in New York by their American conferees and driven to Detroit. The driving schedule was arranged so as to familiarize the Europeans with night driving conditions in this country.

Among the visiting delegates was SAE member Pierre Cibie, of Paris.

Americans at the meeting were: P. J. Kent, Chrysler, chairman of the ISO Liaison Committee; G. L. McCain, Chrysler; M. R. Denny, GM Overseas Division; H. C. Doane, Buick; F. L. Goodell, Ford; M. P. deBlumenthal, Studebaker-Packard; J. H. Hunt; G. J. Gaudaen, AMA Staff; and Don Blanchard, SAE Staff.

New Aero Engine Head

W. G. Lundquist

W. G. LUNDQUIST succeeds A. E. Smith, of Pratt & Whitney, as chairman of the Aircraft Engine Division, of the SAE Aeronautics Committee. Lundquist is vice-president and director of engineering of the Wright Aeronautical Division, Curtiss-Wright Corp. Reporting to him as chairman of the Division will be six main committees and seven subcommittees charged with developing standards and specifications for aircraft engines and their components.

Brake Buildup Time Investigated

MAINTENANCE standards and procedures for determining and eliminating excessive application and build up time in air and vacuum-actuated brake systems are being developed by the SAE Transportation and Maintenance Technical Committee. This will entail establishing points in brake systems at which to make measurements of application and buildup time. Then, practical limits for the time at these points most be specified. The pressure (vacuum and air) for the end point of the time measurement must be set, too.

To enable maintenance men to compare actual buildup time with values recommended by manufacturers, an inexpensive and simple timing instrument is sought. If such a device is developed, its performance specifications must be established.

It is hoped that the common causes of excessive application and buildup times will be determined and procedure suggested for their correction.

Aero Materials Specs Reviewed by Industry

DRAFTS of twelve SAE Aeronautical Materials Specifications are currently being circulated to industry for comment and criticism by the SAE Aeronautical Materials Specifications Division.

Copies of all these specifications are available for review from the SAE Aeronautical Department, 29 West 39 Street, New York 18, N. Y.

The specifications under review are:

- AMS 2201C—Tolerances, Aluminum and Aluminum Alloy Bar, Rod, Shapes, and Wire—Rolled or Drawn;
- AMS 2202B—Tolerances, Aluminum and Aluminum Alloy Sheet and Plate;
- AMS 2203C—Tolerances, Aluminum Alloy Drawn Tube;
- AMS 4902—Titanium Sheet and Strip, Annealed—40,000 psi Yield;
- AMS 7277—Rings, Sealing, Synthetic Rubber, Phosphate Ester Hydraulic Fluid Resistant (70 Min);

CONTINUED ON PAGE 110

1955 SAE GOLDEN ANNIVERSARY NATIONAL MEETINGS . . .

June 12-17
Summer Meeting
Chalfonte-Haddon Hall,
Atlantic City, N. J.

September 12-15
Tractor Meeting and
Production Forum
Hotel Schroeder, Milwaukee,
Wis.

October 31-November 2
Transportation Meeting
The Chase, St. Louis, Mo.

August 15-17
West Coast Meeting
Hotel Multnomah, Portland,
Ore.

October 11-15
Aeronautic Meeting
Aircraft Production Forum,
and Aircraft Engineering
Display
Hotel Statler, Los Angeles, Calif.

November 2-4
Diesel Engine Meeting
The Chase, St. Louis, Mo.

November 9-10
Fuels and Lubricants Meeting
The Bellevue-Stratford
Philadelphia, Pennsylvania

1956 SAE National Meetings . . .

January 9-13
Annual Meeting
The Sheraton-Cadillac Hotel
and Hotel Statler, Detroit,
Michigan

March 6-8
Passenger Car, Body,
and Materials Meeting
Hotel Statler
Detroit, Mich.

March 19-21
National Production Meeting
and Forum
Hotel Statler, Cleveland, Ohio

Sperry Memorial Award to be Co-sponsored by SAE

Robert B. Lea

SAE WILL CO-SPONSOR THE ELMER A. SPERRY MEMORIAL AWARD. Represented on the Board of Award, SAE will serve with the American Society of Mechanical Engineers, the American Institute of Electrical Engineers, and the Society of Naval Architects and Marine Engineers in selecting the winner. **ROBERT B. LEA** has been elected chairman of the Board of Award for 1955.

The Elmer A. Sperry Award will be bestowed in recognition of "a distinguished engineering contribution which through application, proved in actual service, has advanced the art of transportation whether by land, sea or air." A unique feature of the award is that it may be made to an individual or to a group of individuals.

The first award, consisting of a specially designed bronze medal, a certificate, a bound copy of the biography of Elmer A. Sperry by **JEROME C. HUNSAKER,** and an honorarium, will be conferred this fall during ASME's Diamond Jubilee Annual Meeting in Chicago.

"Dr. Sperry, of gyroscope fame, was one of America's great inventors. Through more than 400 patents, he was responsible for some of this country's most important peacetime and wartime

Hunsaker

Littlewood

discoveries and engineering advances. His genius and perseverance increased the facilities and safety of many types of transportation," said David W. R. Morgan, president of ASME.

The award has been made possible by Dr. Sperry's daughter Helen (Mrs. Robert Brooke Lea) and his son, **ELMER A. SPERRY, JR.**

J. C. HUNSAKER, Massachusetts Institute of Technology, and SAE Past-President **WILLIAM LITTLEWOOD**, American Airlines, have been appointed to represent SAE on the Board of Award. The Board has agreed that presentation of the award will be at a meeting of the society which appears appropriate as representing the field of achievement.

Horning Rules of Award Amended

Council has approved amending Rule 3 of the Horning Memorial Rules of Award to read as follows:

> "All papers having not more than two authors on the subjects indicated above which are presented before Society or Section meetings during each calendar year shall be eligible to receive consideration by the Board of Award."

In accordance with the provisions of the rules of the award, this change will become effective January, 1956.

SAE Section Meetings

Canadian—June 23

Annual Golf Game. Westmount Golf & Country Club, Kitchener, Ontario. Golf starting at noon. Dinner 7:00 p.m.

Cleveland—June 23

Elyria Country Club, Elyria, Ohio. Annual Golf Outing.

Texas—July 8

Transportation and Maintenance.

BEGINNING WITH 1956 . . .

. . . SAE Roster goes to every member—in new, larger size

Beginning with 1956, SAE Roster will go to every SAE member without his having to make a special request for it. It will go to him in a new and larger page-size. He will receive it about the end of January, as in the past.

The new format and procedure result from action by SAE Council at its April 14 meeting in Peoria that: "Beginning with 1956, the SAE Roster shall be published as a separately-bound supplement to, or 13th issue of, the SAE Journal, in the page-size and format of the Journal, and carrying a standard Journal cover."

Presenting the proposal to Council, President C. G. A. Rosen said that, when presented to the Council's Executive Committee prior to the Peoria meeting, it had been pointed out that the change would bring about two results:

a) Permit production and mailing of the 1956 Roster for $10,000 less than it will cost in its present form; and

b) Make it available to every SAE member without action on his part. (The Roster is currently distributed to such members as check for it on their due bills. About 75% of members do this.)

In discussion prior to the motion, the proposal was first analyzed, at President Rosen's request, by two members of the Council's Executive Committee who were present. All Executive Committee members, President Rosen said, had examined the proposal prior to the meeting.

Results of the Council's careful exploration of various ways in which a different handling of the Roster might bring financial advantage with satisfactory service to members were reported. Possibilities mentioned were: (1) Selling advertising in the present Roster format; (2) carrying advertising in the proposed new Journal format; (3) combining the Handbook and the Roster within the same cover; and (4) the proposal to publish the Roster as a separately-bound supplement of the Journal.

Every Council member present expressed approval of going to the new format. Some discussion of possibilities or need for a heavier cover than that of the Journal resulted in general agreement that the change be made using regular Journal covers and that a review be made a year later in case experience indicated any measurable degree of dissatisfaction.

About SAE Members

Mueller

Van Halteren

Wilson

Duncan

Smith

Leeds

Valentine

Sennstrom

Warner

Campbell

Evans

Lang

CARL MUELLER has been appointed vice-president in charge of engineering for Lincoln Engineering Co. He was formerly director of engineering.

Mueller has been associated with Lincoln Engineering, manufacturer of lubricating equipment, for twenty years.

C. J. Van HALTEREN has been appointed engineering representative of the Detroit Office for West Coast Operations of Chrysler Corp. He was formerly staff engineer, DeSoto Motor Corp., Chrysler Corp.

Van Halteren was SAE Detroit Section junior group chairman in 1952–1953 and for several years has been company representative at DeSoto.

DONALD K. WILSON has been appointed director of transportation for Niagara Mohawk Power Corp., Albany, N. Y. He has been superintendent of automotive equipment for the company's eastern division since 1930.

Wilson served as SAE Vice-President representing Transportation and Maintenance Activity in 1947.

ROBERT F. DUNCAN has been elected to the newly-created position of executive vice-president of Calumet Refining Co. He has been secretary and treasurer and a member of the board of directors since 1950. He continues to serve as treasurer.

EDWIN R. SMITH, JR. has been elected to the office of executive vice-president and general manager of Seneca Falls Machine Co. Since 1953 Smith has served as vice-president and assistant treasurer.

NORMAN LEEDS, JR. has been elected to the board of directors of Raybestos-Manhattan, Inc. He is factory manager of the Raybestos Division in Bridgeport, Conn. He has served that division 29 years.

R. H. VALENTINE is now serving as Detroit zone manager for New Departure Division of GMC. He moved to Detroit from Cleveland, where he was also zone manager. The Detroit zone covers all of Michigan and the northwest corner of Ohio.

HAROLD R. SENNSTROM, is now associated with American Bosch Division, American Bosch Arma Corp., as vice-president in charge of product development. Sennstrom moves to American Bosch from American Locomotive Co. of Schenectady, N. Y., where he served as new product sales promotion manager.

HAROLD G. WARNER has been appointed assistant works manager of the Cadillac Motor Car Division, GMC. He has been superintendent of Cadillac's Methods and Equipment Division.

BYRON F. CAMPBELL is now associated with Allen Electric & Equipment Co., Kalamazoo, Mich., as vice-president, director of engineering.

Campbell had been executive engineer for Massey-Harris-Ferguson Co. of Detroit.

GLENN EVANS has been appointed to head the task force that will convert the Marion, Ohio plant of Whirlpool Corp. to the production of automatic clothes dryers. Whirlpool recently purchased the plant from Motor Products Corp.

ARTHUR W. LANG has been appointed manager of Trailmobile, Inc.'s factory branch in Buffalo, N. Y. He was formerly manager of the Dayton, Ohio branch.

ERNEST W. FULLER has joined Lockheed Aircraft Corp., Georgia Division, as staff engineer—Preliminary Design. He had been manager of the Poly-Plastics Division, REF Mfg. Corp., Mineola, N. Y.

MAX HOFFMAN has taken the position of chief development engineer with Titan Valve and Mfg. Co., Cleveland. He was engineer with Hercules Motors Corp., Canton, Ohio.

DONALD D. WEIDHUNER is now serving as chief, Power Plant Engineering Unit, Office of Chief of Transportation, Aviation Division, Department of the Army. He was project engineer, Power Plant Laboratory, Wright Air Development Center, Wright-Patterson Air Force Base, Ohio.

SAE Past President **WILLIAM LITTLEWOOD**, vice-president of American Airlines, Inc., spoke on "Air Transport Problems of the Future" to members of the Esso Research Club. This is an association of technical employees of the Standard Oil Co. (New Jersey) and affiliates.

JOHN HIRSCHFELDER is now associated with Food Machinery & Chemical Corp., San Jose, Calif. as a design engineer.

Robinson

Twells

Duncan

Karr

Riopelle

Ingersoll

GEORGE E. ENGELMANN is now associated with Mack Trucks, Inc. in New York City as assistant to the president. He had formerly been manager of the Washington office of Studebaker-Packard Corp.

HARRY GUTTMAN is now associated with Penberthy Injector Co., Detroit, as design engineer. Formerly he was junior product engineer for Houdaille-Hershey Corp.

EARL HOBEIN has been appointed plant manager of the Berea Rubber Co., Berea, Ky. The Berea plant manufactures O-rings for the Rubber Products Division of Parker Appliance Co., Cleveland.

Hobein had been assistant to the sales manager of the company's Rubber Products Division.

ROGER W. ROBINSON has been appointed sales manager for Clark Equipment Co.'s Transmission Division, Jackson, Mich. He will be responsible for sales of the complete line of Clark transmissions, torque converters, and power train packaged units.

With the company since 1941, he was previously company representative handling transmission and axle sales to earthmoving and agricultural equipment manufacturers.

ROBERT TWELLS, vice-president of Electric Auto-Lite Co., has been elected president of the American Ceramic Society. He has been a member of the Society since 1920, is a Fellow, and has served in numerous capacities in the organization, including treasurer, trustee, and vice-president.

TURNER A. DUNCAN has been elected president and chairman of the executive committee of Turner Mfg. Co., Statesville, N. C. He has also been re-elected to the board of directors. Duncan has been serving as vice-president and general manager of the company.

RICHARD T. KARR has become general sales manager, a newly created position in the Equipment Sales Division of Purolator Products, Inc., Rahway, N. J. Since 1952 Karr has been serving as assistant to the vice-president in charge of sales.

EARL F. RIOPELLE is now vice-president in charge of engineering and research for the Lunkenheimer Co. of Cincinnati. He had previously been serving in the same position with Houdaille-Hershey Corp., Highland Park, Mich.

ROY C. INGERSOLL, president of Borg-Warner Corp., has become chairman of the board of directors, as well as president. He had become president of the corporation in 1950.

HENRY JENNINGS, technical editor, **Fleet Owner**, McGraw-Hill Publishing Co.; **CHARLES FIRMBACK**, safety inspector, Interstate Commerce Commission; **WILLIAM KISSAM**, automotive equipment and research engineer, Tide Water Associated Oil Co.; and **P. E. TOBIN**, regional manager of North Atlantic Region, White Motor Co., are serving on the planning committee for the Second Annual Course in Motor Vehicle Maintenance, sponsored by the Center for Safety Education of New York University.

RICHARD W. BLAIR is now associated with Chicago Rawhide Mfg. Co. as leader of Research & Development Section. He had served as project engineer for Wright Aeronautical Division, Curtiss-Wright Corp.

HAROLD R. BERG, after an extended leave of absence, will assume new duties for Ethyl Corp. as sales coordinator. He was general manager of Antiknock Sales.

LEONARD L. HUXTABLE has been named assistant sales manager of Ethyl's Southern region, having served as district manager in Tulsa.

LAWRENCE D. REIS has been appointed to replace Huxtable as district manager in Tulsa. He had been account representative for the company in Tulsa.

These organizational changes follow the formation of Ethyl Corp. of Canada, Ltd.

CHARLES S. MOTT, General Motors director and chairman of the board of United States Sugar Corp., has been presented a special Stevens Metropolitan Club Distinguished Service Award in recognition of his outstanding service to the engineering profession.

The club, whose members are graduates of Stevens Institute of Technology, said the outstanding service for which Mott received the award "includes his great humanitarian work as well as his technical and business accomplishments."

NICHOLAS FODOR is now serving as consulting engineer to companies engaged in the manufacture of governors, aircraft hydraulic controls, and diesel engine accessories. He is located in Wilmette, Ill.

Fodor had served with Micro-Precision, Inc. as executive vice-president and general manager.

NORMAN C. PENFOLD has been appointed vice-president of Southwest Research Institute. He will continue to direct the automotive, fuels, and lubricants research and the photo laboratory. His special fields are internal-combustion engines, fuels and lubricants, use of engines as research tools in evaluation of fuels and lubricants, heat power and combustion, automotive petroleum products, and research management.

HARRY C. DOANE, assistant chief engineer, Buick Motor Division, GMC, and Gerald M. Rassweiler of GMC Research Laboratory, have recently written a report entitled "Cooperative Road Tests of Night Visibility Through Heat Absorbing Glass." Night road tests were conducted cooperatively by the Automobile Manufacturers Association, General Motors Corp., and General Electric Co. for the Highway Research Board.

They found that seeing distance through tinted, heat-absorbing glass was only 3% less than through ordinary windshield glass. This amount is considered insignificant.

A Ford Story

William Clay and Benson Ford

Mills

Krafve

ERNEST R. BREECH, chairman of the board, Ford Motor Co., has announced the election of two new-vice-presidents. At the same time, a major organizational and management expansion has been announced by **L. D. CRUSOE,** executive vice-president, Car and Truck Divisions.

The organizational expansion includes the establishment of separate Lincoln and Mercury Divisions and the formation of a new Special Products Division.

BENSON FORD, who has been vice-president and general manager of the Lincoln-Mercury Division, assumes increased responsibilities in the new position of vice-president and group director—Mercury and Special Products Divisions.

WILLIAM CLAY FORD, who continues as vice-president and general manager of the Continental Division, will assume the added responsibilities of vice-president and group director—Lincoln and Continental Divisions.

BEN D. MILLS has been elected vice-president and general manager of the Lincoln Division. He will also continue as assistant general manager of the Continental Division.

R. E. KRAFVE, who has been assistant general manager of the Lincoln-Mercury Division, has been appointed general manager of the Special Products Division.

ROBERT CASS, 1953 President of SAE, has recently completed a tour of England and Scotland, presenting the James Clayton Lecture.

The lecture, delivered in London, Bristol, Manchester, Glasgow, and Luton, was made possible by James Clayton, a member of the Institution of Mechanical Engineers, who left money for the purpose of "encouraging mechanical engineering science."

RUPERT A. JARBOE has become vice-president—Engineering of Electra Mfg. Co., Independence, Kan. He will be concerned with the design and development of automotive and electrical parts. Formerly he served as chief engineer.

STEPHEN R. NEMETH has taken the position of engineer, Works Technical, with E. I. duPont de Nemours & Co., Inc., at the Savannah River Plant, Augusta, Ga. He had been with duPont in Orange, Texas, as engineer, Technical Section.

EDWARD R. NEEDHAM has moved to Matanzas, Cuba to serve Compania Rayonera Cubana, S. A. as textile research engineer.

Needham has been located in Drummondville, Que., Canada as technical superintendent of Drummondville Cotton Co., Ltd. (Dominion Textile Co., Ltd.)

EDWIN R. BRODEN has been elected executive vice-president of SKF Industries, Inc. He was formerly executive vice-president and a director of Carborundum Co., Niagara Falls, N. Y.

LOUIS F. CRYSTAL has joined Caterpillar Tractor Co. in Peoria as supervising engineer. His new position entails investigating, editing, releasing, and general handling of changes to specifications in the categories of nonmetals, processing, lubricants, coatings, and gear and spline design.

WILLIAM H. CROUSE recently published two books in the McGraw-Hill Automotive Mechanics Series. They are entitled **Automotive Engines** and **Automotive Fuel Lubricating and Cooling Systems.**

Automotive Engines, the first book in the McGraw-Hill Series, gives complete and comprehensive information on the construction, servicing, and repair of the modern American automobile engine.

Automotive Fuel, Lubricating, and Cooling Systems is a practical manual designed to tell why components are designed in certain ways, how they operate, and how to test, service, and repair them.

R. D. OLDFIELD has retired as president of the Western Automatic Machine Screw Co., Elyria, Ohio. He had been with that company 45 years.

Oldfield started with Western Automatic in the plant and was successively salesman, assistant sales manager, sales manager, and president. He will continue as a director and in an advisory capacity.

STEVE TOTH is now associated with Ford Motor Co. as project engineer in the Engine Engineering Department, Engineering Staff.

Toth had been senior designer for GMC Truck & Coach Division, Pontiac, Mich.

EDWARD A. DRURY is now associated with Studebaker-Packard Corp. Government & Industrial Products Division as staff project engineer. He will supervise the design, development, and testing of gas turbine components.

Drury has been project engineer—Development Engineering Department of Thompson Products, Inc. Jet Division.

White

HAROLD S. WHITE, supervisor of the Research Engine Section, Ford Motor Co. Engineering Department, has recently retired. He had served that company since 1946.

White has been chairman of the SAE Engine Committee since its organization in 1947 as an SAE Technical Committee. He has also been an active member of the Detroit Section.

Located in Fort Lauderdale, Fla., his plans for the future include spending as much time as possible on his new boat. This may involve membership in the Florida Power Squadron.

WALTER LOING McCARTHY is now associated with Frigidaire Division, GMC, as works manager. He formerly held the same position with Delco-Remy Division in Anderson, Ind.

HOWARD WILLETT, JR., president of Willett Truck Leasing Co., Chicago, has been elected president of the Car-Truck Renting and Leasing Association, Chicago. The objectives of this newly formed group are to be exclusively concerned with legislative and regulatory matters as they apply to non-carrier lessors who supply automobiles or trucks without drivers.

McCLELLAN BERSTON is now located in Detroit as process engineer for the Buick-Oldsmobile-Pontiac Assembly Division, GMC. He has been in Doraville, Ga. as production engineer for that division.

Berston served as a member of SAE Atlanta Section's Membership Committee in 1953-1954.

CLIFF H. DUNN is now service supervisor, Motor Trucks, for International Harvester Co. He was regional service representative for that company.

PROF. CHAUNCEY W. SMITH will retire from the staff of the University of Nebraska College of Agriculture on July 1. He will then leave for the Republic of Colombia, where he will be engaged in agricultural engineering development.

Smith will work for at least two years under the Point Four Program with the experiment station at Palmira.

He served as SAE Vice-President representing Tractor & Industrial Engineering in 1941.

Smith

Tuttle

J. C. TUTTLE has been named consulting engineer for the automotive engineering division of Goodyear Tire & Rubber Co. This division works with the engineering departments of Goodyear original equipment accounts, regarding the design and application of tires for original equipment.

Tuttle had been manager of the division since near the end of World War II. He has been with the company 28 years.

G. C. YOUNIE has been named manager of Solar Aircraft Co.'s Southwest office in Fort Worth, Texas. He had served as chief engineer with Braniff Airways, Inc., Dallas.

HAROLD W. CLOUD has taken the position of general manager—Linden Region for Rheem Mfg. Co. He had previously served as general manager for Continental Die Casting Corp., Detroit.

DALE W. McKEE is now associated with Clark Equipment Co. as engineering manager, Special Development Section, Industrial Truck Division. He had served as vice-president, Engineering with Baker-Lull Corp., Minneapolis.

E. M. GREER has been elected a director for a three year term of the National Fluid Power Association. He is president of Greer Hydraulics, Inc., Jamaica, Long Island, N. Y.

VINCENT C. GILBERT, formerly design engineer for Food Machinery and Chemical Co., San Jose, Calif., is now president of Gilbert Mfg. Co., Los Gatos, Calif.

Gilbert has been secretary of SAE Northern California South Bay Division in 1954-1955.

J. W. JOLLY is now general manager of Standard Tube & T.I., Ltd., Woodstock, Ont., Canada. He has been serving in the same position with Timken Roller Bearing Co., St. Thomas, Ont., Canada.

FREDERIC C. MELDOLA, formerly assistant chassis engineer with White Motor Co., is now associated with Fuller Mfg. Corp. as a research engineer.

RUSSELL L. BRANCHFIELD is now western regional manager for the Transportation & Distribution Division of Armour & Co., Chicago. He had been serving as assistant manager of the automotive department, Maintenance Section.

JOHN BUCKWALTER, chief engineer at the Long Beach plant of Douglas Aircraft Co., has been named assistant to **A. E. RAYMOND**, vice-president, Engineering, in the general office at Santa Monica.

CHARLES BALOUGH, JR. has become assistant sales manager of Hercules Motors Corp., Canton, Ohio. He had been serving as assistant to the executive vice-president.

HARRY G. STODDARD has been elected chairman of the board of directors of Wyman-Gordon Co. He has been president of the company since 1931. Wyman-Gordon is a producer of forgings of steel, magnesium, and titanium.

GILBERT H. SWART, previously chief chemist of B. F. Goodrich Co., Akron, is now associated with General Tire & Rubber Co. of Akron as director of research.

NORMAN L. DEUBLE has been appointed manager of the newly created metallurgical development division of Climax Molybdenum Co. Since joining Climax Molybdenum in 1947, he has won wide recognition as an authority on the development of metallic molybdenum produced by the arc-casting process and has worked closely with users of these materials in the electronics and high temperature fields.

Henderson

Teree

LESTER J. HENDERSON has been appointed vice-president of the newly-formed Aviation Division of Weatherhead Co. located in Antwerp, Ohio. He has been serving as sales manager of the Aviation Division in Cleveland. Henderson has been chairman of SAE Committee A-3 for thirteen years.

B. R. TEREE, chief engineer of the Aircraft Division in Cleveland, will serve with Henderson in Antwerp as his right hand man in charge of engineering. Teree is chairman of SAE Committee A-6.

MONROE A. MALLER is now located in Perivale, Greenford, Middlesex, England as sales manager, Aeronautical Division, Honeywell-Brown, Ltd.

Maller had been serving the parent company, Minneapolis-Honeywell Regulator Co. in New York, as assistant regional manager for the aeronautical division.

EDWARD F. TAUSK has joined Diamond T Motor Car Co. Engineering Department. He had been draftsman-checker with United Parts Mfg. Co., Brake Parts Division.

BRUCE SMITH has been appointed vice-president—engineering of Ryan Aeronautics Co. Having joined Ryan as chief engineer of the airplane division, Smith has been serving as director of engineering.

Maples

Wiedenmann

JAMES W. MAPLES has been promoted to director of manufacturing for all Firestone rubber manufacturing plants in the United States and Canada. He formerly served as production manager of the company's tire plants in this country.

HERBERT H. WIEDENMANN, who has been in charge of the Akron tire plants, has been appointed production manager of the company's tire plants, to replace Maples.

FREDERICK J. DeWITT has recently been elected president of Tropical Paint Co., a wholly owned subsidiary of Parker Rust Proof Co. of Detroit (See p. 174 Feb. Journal).


DeWitt


Ivanso

EUGENE V. IVANSO is one of the incorporators and officers of the March Corp., recently organized to engage in applied technical sales of specialized products and services in the high temperature, corrosion resisting, and metallurgical fields. The new organization will represent a number of well established concerns in the Alloy and Steel Fabrication, and special castings fields.

PHILIP S. WEBSTER is now special development engineer, Engine Division, White Motor Co. He had been product design checker, Automotive Division, Continental Motors Corp.

Webster has served as vice-chairman of student activities for SAE Western Michigan Section 1952–1955.

H. W. AUSTROW is now a project engineer with Ingersoll Kalamazoo Division of Borg-Warner Corp., working principally on Navy track-laying amphibians. He was design engineer for Jered Industries, Inc., Hazel Park, Mich.

KAZIMIERZ T. KSIESKI is now associated with Parker Aircraft Co., Los Angeles, as project engineer. He previously served in the same position for Aero Supply Mfg. Co., Inc., Corry, Pa.

JOHN J. NARGI is now general manager of the T-C Division, Empire Tool Products, Inc., Garden City, Long Island, N. Y. He had been chief engineer of B G Corp., Ridgefield, N. J.

Nargi is chairman of SAE Committee AE-2 and has been a member of the SAE Metropolitan Section Golden Anniversary Committee.

C. M. WHELAN, manager of the Detroit sales office of Aluminum Co. of America, has recently retired. He began his career with Alcoa as an hydraulic engineer in Pittsburgh in 1917. He has been serving as manager of the Detroit office since 1941.

J. W. COLLINS, previously of the company's Milwaukee sales office, has been named assistant district sales manager in Detroit.

WILLIAM W. WATSON has joined the Pineapple Division of Libby, McNeill & Libby Co. in Honolulu, Hawaii as automotive engineer. He was formerly manager for transportation for ARO, Inc. at the Arnold Engineering Development Center in Tullahoma, Tenn.

CORNELL JANEWAY has taken the position of research engineer with Kellogg Division of American Brake Shoe Co. He had been assistant chief engineer with Taub Engineering Co.

Janeway served as SAE Washington Section vice-chairman (Engineering) in 1954–1955.

ERNEST L. KORB, sales manager of the Pure Oil Co.'s wholesale marketing division since 1951, has been assigned to special executive duties under the vice-president for retail marketing.

C. S. HANSEN, manager of the national accounts department of the retail division, has replaced Korb as wholesale sales manager.

ROBERT P. FORELLA has joined Pratt & Whitney Aircraft Division, United Aircraft Corp., as test engineer. He will be concerned with the development and maintenance of fuel system components for experimental gas turbine engines.

Forella was junior test engineer with Chevrolet Motor Division, GMC, in Flint, Mich.

JOHN L. ROBERTS has taken the position of product analyst, Staff Research & Development, Thompson Products, Inc. He has been senior project engineer at Wright-Patterson Air Force Base, Ohio.

Roberts has been SAE Dayton Section vice-chairman (Aeronautics) in 1954–1955.

JOHN H. SMITH is now located in Sao Paulo, Brazil as chief engineer with Caterpillar Brasil, S. A., MaQuinas E Pecas. He had been staff engineer for Caterpillar in Peoria.

Smith has served as program chairman and secretary of SAE Central Illinois Section.

WILLIAM F. BURROWS has been named general manager of the new diesel engine division of White Motor Co., which has been formed as a result of the acquisition of the engine division of National Supply Co., Springfield, Ohio.

A first step will be development of a line of heavy-duty, light-weight, high-speed diesels in the 100 to 400 hp range.

JOSEPH G. MACEYKA has joined Link Aviation, Inc., Binghamton, N. Y. as methods engineer. He was tool design analyst for Pratt & Whitney Aircraft Division, United Aircraft Corp.

DR. AUGUSTUS B. KINZEL has been elected vice-president—Research of Union Carbide and Carbon Corp. He has been actively engaged in research work with Union Carbide since 1926. Since 1954 he has been serving as director of research.

ROLLY W. FITCH has become vice-president of Auto-Lite Battery Corp., Toledo, Ohio. He had been serving as plant manager for the corporation in Owosso, Mich.

HAROLD C. SCHINDLER has become chief design engineer—Scraper Section for Euclid Division, GMC in Cleveland. He has been serving that division as development engineer.

Schindler served for three years as secretary of SAE Construction and Industrial Technical Committee IV—Hydraulic Power Controls.

JOHN C. PURCELL is now in Field Product Section, Engineering Department, Chevrolet Motor Division, GMC. He serves as liaison with Field Service & Engineering Department on field problems, engineering changes, and product improvement.

He had been staff engineer—Field Service for Cadillac Cleveland Tank Plant, GMC.

DAVID H. C. HOH has taken the position of design engineer with Fairbanks-Morse & Co., Beloit, Wis. He has been research engineer for Chain Belt Co. of Milwaukee.

With Fairbanks-Morse Hoh will be concerned with the design and development of a mechanical governor and centrifugal clutch.

RUSSELL M. WHEELER has been made chief engineer of the Seneca Falls Machine Co. He has been serving as works manager of the company.


Wheeler


Barnes

ROBERT E. BARNES, vice-president of the Carburetion Division of American Liquid Gas Corp., will be the instructor of a special class in "Carburetion" to be held at the University of Florida Summer School. Engines will be available to permit students to make actual set-ups, installations, and adjustments necessary to obtain a working knowledge of internal combustion engines operating on liquefied petroleum gas.

JOHN V. DUNN, vice-president and national fleet representative of Wheels, Inc., recently celebrated his 30th anniversary with the corporation. He has served almost continuously as a specialist in the problems related to wheels and rims on the vehicles of highway transportation.

SAMUEL G. RAE, formerly manager of automotive sales for Owens-Corning Fiberglas Corp., is now automotive sales representative for the company in Detroit. He works with the engineers of GMC and associated fabricators in solving thermal, acoustical, shock absorbing, and trim problems.

ROBERT M. PALMER is now a manufacturer's agent in Grosse Pointe Woods, Mich. He is concerned with sales of industrial coolant filtration products.

Palmer had formerly been technical data supervisor for Ross Roy, Inc., Detroit.

CONTINUED ON PAGE 112

Obituaries

GEORGE T. HAMMERSHAIMB

George T. Hammershaimb, consulting engineer for General Electric Co., Knolls Atomic Power Laboratory, died March 22. He was 58.

Hammershaimb was born in Winterthur, Switzerland and attended the Technical University of Zurich, graduating with an M.E. He later got his doctorate from the University of Geneva.

In Switzerland, Hammershaimb was a draftsman and designer for Piccard Pictet & Co. and Sulzer Bros. In between, he spent five years in the United States as designer for Norberg Mfg. Co.

He returned to Norberg in 1938 and served as designer and research engineer for that company until 1944. He then joined Busch Sulzer Bros. Diesel Engine Co., St. Louis as engineer in charge of high speed diesel engines and also became a citizen of the United States.

As well as serving as consulting engineer for General Electric, Hammershaimb served in the same capacity for Allstates Engineering Co. of Albany, N. Y.

HENRY T. THORKILDSEN

Henry T. Thorkildsen, director of purchases for Wisconsin Motor Corp., died April 17, after a long illness. He was 63.

Thorkildsen had served the Wisconsin Motor organization since 1910 and earned the reputation for being one of the Midwest's best known purchasing agents in the metal working field. He was a member of the Milwaukee Association of Purchasing Agents.

He had been a member of SAE since 1917.

RENE M. PETARD

Rene M. Petard, Life Member of SAE since 1919, died at his home, Chateau de Neville, Neville en Caux, Seine, Inferieure, France on April 8. He was 69.

Petard received his higher education at the University of Paris. His early career consisted of employment as designer and constructing engineer with leading automobile builders. When he joined the Society in 1907, he was serving as European branch manager for Mitchell-Lewis Motor Co. of Racine, Wis. He became chief engineer for the company in 1913.

In 1920 Petard joined the L. P. C. Motor Co. of Racine. He returned soon after to Paris as engineer merchant manufacturer's representative, serving on the side as Paris correspondent for the Automotive Daily News.

He joined Studebaker Corp. in 1928 as manager for France and continued in that position until 1931 when he retired as consulting engineer, technical and sales.

MAJOR FRANK B. HALFORD

Maj. Frank B. Halford, one of the world's foremost aircraft engine designers, died at his home April 16. He was chairman and technical director of the De Havilland Engine Co., Edgware, Middlesex, England, and a director of the De Havilland Aircraft Co.

In 1941 he developed the Napier Sabre, an unorthodox engine at that time, that developed more power than the London-to-Edinburgh express train.

He joined the R.A.F. when it was still the Royal Flying Corps and was a flying instructor in France in 1914. He later turned his genius to designing and developed many engines, one of which was the Circus, composed of standard automobile parts and cheap to manufacture.

His latest engine, the Gyron, is a turbojet designed for supersonic speeds.

W. A. ROBERTS

W. A. Roberts, president of Allis-Chalmers Mfg. Co., died April 12 following a heart attack.

He began his career with Allis-Chalmers in 1924 as a salesman for the firm's tractor branch in Wichita, Kan. In 1926, the company transferred him to Canada as Canadian sales representative.

He moved to the Milwaukee headquarters in 1930 as agricultural sales manager of the tractor division. In 1931 he was named general sales manager. By 1951 he had become president of the firm.

Last fall Roberts was named by President Eisenhower to a five-man national highway advisory committee. He was appointed by the Governor of Wisconsin as chairman of the Wisconsin Turnpike Commission. He was also a director of the National Safety Council and the Agricultural Department Committee of the Chamber of Commerce of the United States.

LT. COL. G. G. EDWARDS

Lt. Col. G. G. Edwards, U. S. M. C., was killed in a military transport plane crash in Hawaii. He had joined SAE in 1953.

With the Marine Corps at Camp Lejeune, N. C., he served continuously with Motor Transport as an instructor on all phases of automatic equipment.

Previous to his service with the Marines, Edwards had attended Sweeny's Automotive & Tractor School, Kansas City, Mo.

WALTER C. BAKER

Walter C. Baker, member of SAE since 1905 and Life Member since 1917, died April 26. He was 87.

The name Baker is best recalled in the "Baker Electric", one of the first electric cars marketed in 1897. This car was popular because of its silent and easy operation, but finally lost out to the internal combustion engine automobiles.

Baker achieved many automotive firsts. He was credited with developing the first left-handed steering system, replacement of the chain drive by metal-to-metal transmission, and the ball-bearing "full floating" rear axle.

When Baker joined SAE in 1905, he was president of Baker Motor Vehicle Co., Cleveland. He later merged this firm with Rausch & Lang Carriage Co. during World War I. Now known as Baker-Raulang Co., the successor manufactures automotive equipment.

from the Sections

Baltimore

Field Editor H. T. Cline
April 14

GM'S PRIMARY AUTOMOTIVE GAS TURBINE EXPERIMENTS center on the Turbocruiser, a regular GMC transit bus with diesel engine replaced by a turbine. Because commercial or heavy duty application can best exploit the advantages of the gas turbine, it is probable that initial application will be made in these fields.

William A. Turunen, head of the Gas Turbines Department, GM Research Laboratories, said the bus is merely a test vehicle, used because its engine compartment is roomy enough for test equipment. It can be ballasted with varying loads and can carry passengers for demonstration purposes.

The driver has the same controls as the driver of a conventional bus. At the rear of the Turbocruiser is an instrument panel that provides test engineers with complete engine data.

Commenting on power-to-weight ratio of the two GM Whirlfire engines, Turunen remarked that in both cases **a saving in weight has been accomplished without sacrificing strength of components.** Automotive rather than aircraft design practice was followed throughout.

New England

Field Editor G. T. Brown
April 5

IN AN EMERGENCY the ability to stop a vehicle quickly is the most important factor for consideration, inasmuch as we do not consider human life to be an expendable item. The ability to stop any vehicle depends on many factors involving **engineering, driver reaction time, and materials and maintenance procedures,** and each of these is interrelated and dependent one on the other.

O. E. "Johnny" Johnson, New England Section activity chairman for Bus & Truck Activity, vice-president of Brake and Electric Sales Corp., and speaker for the evening, opened his talk with the preceding remarks. More than 100 members were present.

Tools, maintenance, and materials cannot change driver reaction time, but these three things can be combined to provide a faster acting, smoother brake in any vehicle that is not already in a near perfect state of repair.

In many instances, severe heat checking is the reason for complete failure. There is one type of combination woven and moulded friction materials set which has helped immeasurably in obtaining better "balance" in two-shoe, fixed anchor pin brakes, and one which has helped many operators to greatly improve upon liner and drum life in heavy service.

In very many case of record, in tough highway service, heat checking has been entirely eliminated through the use of these materials and by following good maintenance procedures.

Washington

Field Editor R. J. Auburn
March 15

21,000 HOURS OF WIND TUNNEL TESTING have gone into the development of the Boeing 707. Richard D. Fitzsimmons, assistant manager of Domestic Sales, Boeing Airplane Co., sketched the history of the Boeing jet transport prototype from its initial layouts in 1947.

The Boeing approach for development of a jet powered transport is that it must fit into the present day pattern of landing and take-off field lengths and practices for holding operations as well. The advent of the two-spool high pressure ratio turbojet has made possible a **reasonable fuel consumption at cruising altitudes** and at altitudes expected to be used for holding.

Many designs were conceived and rejected until an acceptable configuration, devised in 1951, indicated the feasibility of marrying two design con-

cepts:

1. for a commercial transport and
2. for a refueling tanker for Strategic Air Command operations.

By 1952 the company decided to invest about **sixteen million dollars** in the construction of a prototype which made its first flight in July, 1954.

The flight test program has now passed the 130 hour mark. The flying qualities of this vehicle are being demonstrated daily.

Chicago

Field Editor P. P. Polko
April 14

THERE SEEMS TO BE NO LIMIT to the problems and the opportunities facing the engineers and scientists. Addressing Chicago Section members and guests, Dr. R. G. Folsom, director, Engineering Research Institute, University of Michigan, quoted the remark, "The easier developments have been accomplished and the more difficult are as yet to be realized."

Folsom's thought-provoking talk about research and the future can be summarized as follows:

1. Research is the hope for the future.
2. Engineering research can be expected to continue to make contributions to our standard of living at an accelerated rate.
3. These contributions will include items and methods beyond our present concepts.
4. Social sciences will be hard pressed, as they are now, to assimilate all these developments and provide new fundamental ideas for the engineers to apply.
5. **The automobile or individual surface transport vehicle will be an increasingly important basic factor in our lives for at least the next 25 years.**
6. These predictions are conservative as one never knows when or where the next technological breakthrough will occur.

A special event of the evening was a stimulating talk by SAE Councilor F. G. Shoemaker, recently retired as chief engineer, Detroit Diesel Engine Division, GMC, as he represented SAE President C. G. A. Rosen.

Shoemaker offered many valuable observations on "the most prominent features that have contributed to the unusual growth and vitality of the SAE and the industries it represents." He pointed out that:

The technical business of the Society is initiated, planned, and executed by the members themselves, and is bound, therefore, to be **timely, and of mutual benefit.** Out of a total membership of over 20,000, at least 2000 are active as officers or members of working committees.

Why belong to SAE? The answer is short and simple—it pays. The only people who do not profit from SAE are the ones who can't read, or don't listen.

The SAE had 5000 members in 1921; 10,000 members in 1944; 20,000 members in 1955. What does this growth signify? The SAE has been **BIG ENOUGH.** As the industry has grown, the engineering fraternity has grown proportionately.

—Submitted by I. R. Dawson

Northern California

Field Editor R. E. Van Sickle
March 23

STUDENTS AND GUESTS FROM FOUR UNIVERSITIES were present at the annual student meeting held this year at the University of Santa Clara. D. L. McKinley, student chairman for the Section, was in charge of the program.

Following the social get-together and dinner, a technical paper on a subject of general interest, "The Use of Radioactive Tracers," was presented by P. L. Pinotti, product engineer with Standard Oil Co. of Calif.

Pinotti explained the **general principles of radioactivity** and described the occurrence of radioactive materials in nature. With the aid of ionization tubes and counters, he demonstrated the shielding required against alpha and beta particles and gamma radiation. He listed many industrial applications of radioactive tracers which make use of the penetrating gamma radiation. He explained in detail the use of such materials in the petroleum industry, with special emphasis on the study of wear in automotive engines.

April 22

THE LARGEST GRAVITY SWITCHING YARD IN THE WEST was visited by the Sacramento-Stockton Division of Northern California Section during the tour of the Southern Pacific Co.'s facilities in Roseville, Calif.

The tour started at a dispatching office filled with communications equipment and automatic business machines. It progressed from there to the famous "hump yard", the gravity switching yard, where automatic timers and "car retarders" are used to control the speed on the free-rolling cars. At the ice loading facilities of the world's largest ice plant, the group saw the docks capable of accommodating **320 box cars at one time.** Diesel locomotives in various stages of overhaul were inspected in the new million dollar engine repair shops.

A technicolor film, "Snow on the Run", depicting the activities and equipment used by the Southern Pacific in keeping the roadbeds clear of snow through the Sierra Nevada Mountains, was shown at the technical session. R. A. Miller, division superintendent for the Southern Pacific at Sacramento, spoke on the activities and the material requirements of the railroads and the role of the railroads in the nation's economy.

Field Editor C. F. Carey
April 12

POWER DEVELOPED BY CENTRAL STATIONS IN THIS COUNTRY HAS DOUBLED approximately every decade for the last 30 or 40 years. Dr. J. Kenneth Salisbury, professor of mechanical engineering at Stanford University and editor-in-chief of **Kent's Mechanical Engineer's Handbook, Power Volume,** discussed this and other interesting facets of mod-

From Section Cameras

Milwaukee April 1

DR. LILLIAN M. GILBRETH, 77 year old grandmother, author, lecturer, head of an engineering firm, and visiting professor at the University of Wisconsin, chats with Section Chairman Ralph Switzer after her recent illness.

Northern California April 27

SECTION MEMBERS GAZE UNDER THE HOOD of a Ford Thunderbird at the recent San Jose Ford Assembly Plant tour. Northern California Section and South Bay Division met jointly.

Detroit April 11

SPEAKER GEORGE B. WATKINS (right), director of research, Libbey - Owens - Ford Glass Co., answers questions from James P. Falvey (left), president, Electric Auto-Lite Co.; and Section Chairman H. E. Chesebrough (center.)

ern power development in his talk "Thermal Power Today and Tomorrow" before the South Bay Division.

Prof. Salisbury, a University of Michigan graduate and a consultant to General Electric Co. and Stanford Research Institute, shed light on many modern developments: gas turbines, ducted fans, free-piston engines, and rockets, for example. Even atomic energy and its ultimate use as an economical fuel was discussed.

April 27

THE BIRTH OF A CAR, always fascinating, was presented in a thoroughly workmanlike and enjoyable fashion, as the Northern California Section and South Bay Division met jointly at the new Ford San Jose Assembly Plant. More than 500 members and guests heard W. E. Burnett, executive engineer, Ford Car Engineering Office, present **"The Thunderbird,"** the story of the development of the new Ford product.

Following a tour of the San Jose plant (during production hours) and a dinner at one of the plant's three cafeterias, Daniel T. McCowan, Ford's San Jose plant traffic manager, entertained and educated with a short coffee talk, "Where Did It Go?" This was the story behind the recent "Big Move" of the Ford operation from Richmond, Calif. to San Jose.

Burnett's presentation was of special interest to the audience. Responsible perhaps more than anyone else for the development of the Thunderbird, Burnett was able to speak with authority. Colorful slides assisted the tracing of the development of the car from **sketches through clay models, through engineering prototypes, and finally to the production stage.**

Besides being honored by the presence of William A. Abbott, Jr., plant manager, members were treated to a special surprise: the unexpected appearance of SAE President C. G. A. Rosen, who spoke briefly and impressively.

Milwaukee

Field Editor F. B. Esty
April 1

"IT IS ALL RIGHT TO MAKE THINGS, BUT WE MUST ALSO MAKE MEN AT THE SAME TIME," said Dr. Lillian M. Gilbreth. Dr. Gilbreth is the 77 year old grandmother from Montclair, N. J., whose active life includes the roles of author, lecturer, head of an engineering firm that applies the study of waste motion to industrial techniques, and presently visiting professor in Mechanical Engineering at the University of Wisconsin.

Proper balance between industrial techniques and human relations is what Dr. Gilbreth called for in meeting the world's demand for increased productivity. Regardless of war or peace, **increased productivity** is needed to meet the world wide demand for a higher standard of living. Additional natural resources must be found and utilized, not only to satisfy the needs of the people, but to provide what people want.

Management is realizing workers must feel they are needed on the job and experience satisfaction in the work they are doing. Production time schedules have eliminated technical interruptions, but they have not eliminated interruptions caused by human beings rather than things.

April 27

TRULY SUCCESSFUL DESIGN MUST TAKE INTO CONSIDERATION CURRENT AND PROSPECTIVE MANUFACTURING FACILITIES was the consensus of opinion of the panel on "Producing the Design", at the Production Forum sponsored by the Milwaukee Section.

Serving on this panel were the following experts: John E. Schoen, professor of engineering, Marquette University; Robert Kelker, welding engineer, A. O. Smith Corp.; E. L. Bruce, planning manager, Caterpillar Tractor Co.; George Kapp, factory superintendent, Heil Co.; George Mork, division engineer, Bucyrus-Erie Co.; and A. Spelick, quality control superintendent, Waukesha Motor Co.

A design must be produced, said the panel, at the least cost with the least expenditures for new tooling. However, advancement in designs and new products cannot and must not be held up because of current facility limitations. In large companies special groups are responsible for the orderly development of new processes and the corrolation of these advancements to product design. Smaller companies can achieve this goal by **close cooperation of all department heads.**

No conclusion was reached on the problem of suitable penalties for inferior workmanship. Each company apparently has its own problems which makes a single uniform policy virtually impossible. This lead to the suggestion that the best way to reduce the need for penalties was to **educate the worker** to the point where no penalty was necessary because of his desire to make only good work.

Detroit

Field Editor W. F. Sherman
April 11

HAILING THE PANORAMIC WINDSHIELD as one of the outstanding landmarks in the development of automotive safety glass for greater driving safety, increased vision, and beauty of design, Dr. George B. Watkins, director of research of Libbey-Owens-Ford Glass Co., said it required ten years to perfect the new windshield.

Fifteen years ago we would have been laying emphasis on the plastic interlayer and methods of combining the glass-plastic layers to form a unitary structure of safety glass. In the last ten years the trend in motor car design has been to achieve **better vision, fewer blind areas, better stream-lining, increased comfort and beauty.** Larger areas of glass have been employed for the accomplishment of all these aims, and they have won ready customer acceptance.

The research into techniques for shaping curved

Twin City April 13

GOING OVER THE SLIDES are (left to right) Section Treasurer D. D. Hornbeck, Speaker J. A. Warren, Ethyl Corp., C. W. Gilmore, and Section Chairman D. J. Breining.

Pittsburgh April 26

COL. WILLARD F. ROCKWELL stated that automation will not threaten employment in automotive or allied industries.

Buffalo March 7

KODAK ENTERTAINS SAE members. Seen together (left to right) are T. F. Robertson, public relations director, Eastman Kodak Co.; SAE Rochester Division Chairman H. H. Dietrich; Buffalo Section Chairman C. L. Nelson; and I. N. Hultman, vice-president, Eastman Kodak Co.

Mid-Michigan March 21

NEW MEMBERS RECEIVE LAPEL PINS at Mid-Michigan Section's March 21 meeting. The speakers were E. K. Von Mertens, American Bosch Arma Corp., and A. F. Braun, Buick Motor Division of GMC.

windshields and the great increase in mechanical facilities required in the glass industry were reported by Watkins, along with a most interesting discussion of the handling problems encountered when curved windshields were adopted.

For a while in 1954, men from Mars and gremlins were blamed for pock marks on windshields. Newspapers all over the country took up the hue and cry that seems to have originated when someone publicized the idea that atomic bomb fall-out was damaging glass. Laboratory investigation established that the marks were those which normally occur from stones and road debris during usage.

Another wild rumor about breakage of windshields when cars were jacked up for a tire change was also discounted quickly by testing. He showed a film demonstrating that even abuse of the windshield did not result in breakage.

The dinner meeting was preceded by a tour through the Electric Auto-Lite Co.'s Stickney Avenue plant. Toastmaster at the dinner was J. P. Falvey, president, Electric Auto-Lite Co.

April 20

6000 ENGINES PER DAY are produced at the Dearborn Engine Plant of Ford Motor Co. This is 30–40% above the plant's rated capacity. Ford passenger car, truck, and Lincoln V-8 engines are produced in this plant.

The season's final activity of the Detroit Section's Junior Group was a field trip through the plant and visit to the exhibits in the Ford Rotunda.

Norman Krecke, plant manager, welcomed the group, gave a short talk on the functions taking place, and introduced the tour guides. Groups of 30 to 35 were guided through the plant where the **latest in automation production facilities** were explained. The processing of the engine from broaching the faces of the blocks to the final assembly was interesting and informative to the Junior members.

—Submitted by G. F. Gass

Pittsburgh

Field Editor D. W. Gow
April 26

AUTOMATION WILL NOT THREATEN EMPLOYMENT in the automotive or allied industries, stated Col. Willard F. Rockwell, chairman of the board, Rockwell Mfg. Co. and Rockwell Spring & Axle Co. As speaker at the Golden Anniversary Meeting of Pittsburgh Section, he reviewed the highlights of the past 50 years in the automotive industry and commented briefly on its future. His personal dealings with many of the pioneers in this field enabled Rockwell to present a detailed and intimate picture of the fantastic growth of the industry.

In presenting a message from SAE President C. G. A. Rosen, 1953 SAE President Robert Cass stressed the great **need for young engineering graduates in the automotive and allied industries.** National security will undoubtedly be influenced to a great extent by the ability of these industries to increase their scientific and engineering forces.

This meeting and Pittsburgh Section as a whole received spotlight publicity in Pittsburgh weekday and Sunday papers, through the efforts of one of the Section's most prominent members, Murray Fahnestock. "Pittsburgh . . . Where Auto Production Begins" is the headline that appeared above the story celebrating **Pittsburgh Section's Silver Anniversary** as well as the Society's Golden Anniversary. A picture of four Pittsburgh Section members who have been with the Section since its formation in 1929 was a feature of the article. The members are C. R. Noll, Gulf Oil Corp.; Dr. W. A. Gruse, Mellon Institute; Murray Fahnestock, **Ford Field** magazine; and C. J. Livingstone, Gulf Oil Corp.

Buffalo

Field Editor D. I. Hall
March 7

THE MOTOR VEHICLE INDUSTRY SPENDS MORE MONEY ON PHOTOGRAPHY AND ALLIED ITEMS THAN ANY OTHER INDUSTRY, followed closely by the aircraft industry, according to Eastman-Kodak figures. A selected group of Kodak engineers and sales personnel conducted a symposium on recent developments and applications in photography of direct interest to automotive and aviation engineers.

Thomas F. Robertson, panel leader, gave a general review of the Kodak plants. Kodak products and their application were reviewed by John Niemeyer with a demonstration of the use and application of hi-speed photography up to **3200 frames/sec.**

Precision measuring equipment was covered by Jack Stop, who showed recent improvements and uses of the contour projector and demonstrated their **axicon aligner** which has been **developed to project a straight line well within an accuracy of .002 in. for 100 ft.**

Mark Purser reviewed the need for and development of the conju-gage gear measuring equipment made by Kodak's Navy Ordnance Division to inspect gears more accurately than previously possible with chart readings of up to 800 magnifications.

—Submitted by E. F. DeTiere

Mid-Michigan

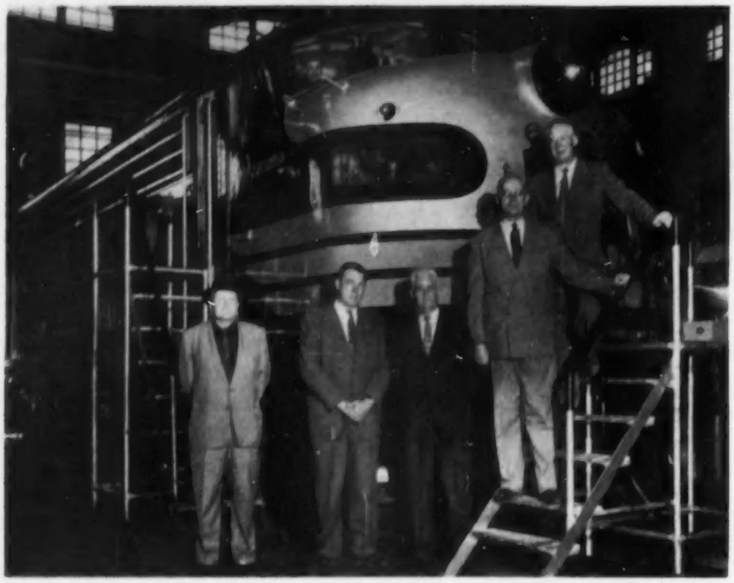
Field Editor R. D. Jacobs, II
March 21

FUEL INJECTION POSSIBILITIES FOR PASSENGER CAR ENGINES were discussed by E. K. Von Mertens, American Bosch Arma Corp., and A. F. Braun, Buick Motor Division of GMC.

Among interesting facts brought out during the discussion was the fact that **reduced head room requirement in the engine compartment,** by 6 in. or more, **will allow styling changes.** Therefore, it is thought that pressure from the styling sections may hasten the adoption of gasoline injection.

The addition of a gasoline injection system increases the hp of a standard engine at the high speed end of the power curve and, therefore, a corresponding increase in the torque at the high speed

Sacramento-Stockton Division April 22



BEFORE FILING THROUGH THIS DIESEL LOCOMOTIVE at the Southern Pacific shops in Roseville, Calif., site of Sacramento-Stockton Division's April meeting, are shown (left to right) Charles Jurisch, Southern Pacific Co.; Division Chairman E. C. Beagle; Division Vice-Chairman—Diesel Fred Dodson; and Division Vice-Chairman —Transportation and Maintenance Frank Morgan.

Northwest April 8

SECTION MEETINGS CHAIRMAN JOHN CONTI (left) appears with Speaker R. G. Fender, GM Truck & Coach Division (center); and Section Vice-Chairman A. D. McLean.

Cleveland April 12

SHARING AN AMUSING VIEW from the speakers' table are (left to right) J. C. Keplinger, president, Hercules Motors Corp.; Speaker George A. Ball, Ethyl Corp.; and Section Vice-Chairman—Akron-Canton John F. Male.

appears.

More accurate fuel distribution to the various cylinders results in improved fuel economy since no cylinder must run too rich to insure that none runs too lean. Since fuel distribution accuracy is not dependent upon manifold design, the manifold, valve porting, and valve timing may be adjusted to improve the engine volumetric efficiency.

At present most automobile companies are experimenting with gasoline injection. **The big problem is still cost.** It is to be noted, however, that multiple throat carburetors are very expensive also and the price difference between the two may disappear.

Northwest

Field Editor S. J. McTaggart
April 8

THE HEART OF THE TRANSMISSION IS THE DIFFERENTIAL PLANETARY LOCATED IN THE FLUID COUPLING, in GM's Twin Hydra-Matic heavy duty truck transmission. R. G. Fender of GMC Truck and Coach Division pointed this out in his talk. The Twin is connected to the engine by a **specially designed fluid coupling** which actually delivers all of the engine torque to the planet carrier of a differential planetary.

The differential planetary is arranged so that the sun gear drives the lower unit and the internal gear drives the upper unit through the front gear train. By its differential action it allows the necessary speed changes in the transmission input shafts so that the upper and lower units can shift independently. Further, it speeds up input rpm, thus reducing torque values, and divides the torque between the upper and lower units. This rpm "speed up" allows the Hydra-Matic portion of the Twin to operate in a speed range where hydraulic controls are similar to passenger car Hydra-Matic design.

The fluid coupling incorporates an anti-creep device called **"spoilers"**, which consists roughly of spring loaded vanes located in the driving member of the fluid coupling to break up the flow of the oil at idle speeds. As the coupling speed is increased, centrifugal force moves the spoilers out of the path of the oil to give maximum torque transmission.

Cleveland

Field Editor W. B. Fiske
April 12

A CAMERA OPERATING AT SPEEDS UP TO 7200 FRAMES PER SECOND was used to get high speed photographs of the combustion process in an engine equipped with a quartz window in the cylinder head.

Speaking on "A Quick Look at Engine Combustion," Dr. George A. Ball, project engineer of Ethyl Corp., brought out in his illustrated talk investigation of four types of combustion phenomena: **normal flames, "cool" flames, "hot" flames,** and **knock.** The talk was a most enlightening one, followed by a highly enthusiastic question and answer period.

Dr. Ball was introduced by John C. Keplinger, president of Hercules Motors Corp. John F. Male of Hercules was technical chairman for the meeting.

Twin City

Field Editor R. V. Rosenwald
Feb. 9

RADAR SPEED DETECTION EQUIPMENT was demonstrated at the annual Ladies Night Dinner meeting. Elmer C. Nordlund, Captain, Minneapolis Police Traffic Department, assisted by Officers Ray Anderson and John Brucciani, discussed automobile safety and selective traffic enforcement programs of the Minneapolis Police Department.

Although the radar equipment is extremely accurate, **actual arrests are usually not made unless the car is clocked between five and ten mph over the posted speed limit,** according to Officer Brucciani. The spot check of traffic speed at various places in Minneapolis has had the effect of reducing the overall number of accidents normally caused by excessive speed.

April 13

MORE THAN 35,000 HOURS OF MULTICYLINDER ENGINE TESTING ON DYNAMOMETERS AND NEARLY 5,000,000 MILES OF ROAD TESTING have been employed by Ethyl Corp. to study the factors influencing surface ignition. Solution of the surface ignition problem becomes increasingly important as automotive engine compression ratios are increased, J. A. Warren of Ethyl Corp. Research Laboratories reported.

In his paper on "The Effects of Deposits on Engine Performance," Warren noted that combustion chamber deposits have at least two undesirable effects on engine performance. First, **they tend to increase the octane number of the gasoline required to suppress ordinary knock.** Second, the **hot deposits can cause surface ignition,** the erratic deposit-ignition of the fuel-air mixture.

The percentage of surface ignitions producing knock becomes larger with increased compression ratio unless higher octane fuels are used to overcome this effect.

The surface-ignition rate was reduced by the use of fuel additives and more volatile lubricating oils.

Southern California

Field Editor W. E. Achor
April 4–6

A THREE-DAY FUELS AND LUBRICANTS SEMINAR was held April 4–6 by Southern California Section. Reaching an average crowd of 150 per evening, the experts told the present day story on heavy-duty lubricants, passenger car fuels and lubricants, and the smog situation, respectively.

"Development and Use of Additives in Lubricating Oils" by Dr. Ulrich B. Bray, president, Bray Chemical Co. and Bray Oil Co., opened the seminar with a discussion of the **latest developments in the heavy-duty lubricating oil field.** This featured the func-

tions of additives and their effectiveness in obtaining desired results in heavy duty service.

The second session offered talks on **hydraulic valve lifters, combustion knock,** and **detergency activity** in passenger car engines. C. K. Parker, Jr., California Research Corp., observed that valve lifter noise at starting is normal and there is not much that can be done about that. Frequent oil changes are recommended to help keep dirt out of the lubricating system and the hydraulic lifters and subsequently to avoid wear in the lifter components.

J. Brent Malin, E. I. duPont de Nemours & Co., Inc., stated that fuel injection may be a possible means for overcoming the combustion knock and compression ratio limitations.

A service in which the detergency activity of used crankcase oils is evaluated was described by Ralph Faber, president, Faber Laboratories. This type of evaluation is most valuable in determining engine conditions.

Exhaust gases and **smog** were the subjects of the third session. Dale H. Hutchison, Air Research Laboratories, Stanford Research Institute said that smog in the Los Angeles Basin is controlled by the rate of emission of pollutants, the turbulence and topography of the area, and inversion during which the cool surface air is held down under a layer of warm air. Some 60% of the pollutants are contributed by the public, while 40% comes from industry.

In presenting his paper "Sources of Air Pollution," Carl Kanter, Los Angeles County Air Pollution Control, explained that since the weather can't be controlled, the elimination of sources of smog is the method being pursued. Many tons of hydrocarbons formerly emitted into the atmosphere are now trapped at the sources.

The final paper of the seminar discussed "Automotive Smog Control Devices." Dr. W. E. Faith, Air Pollution Foundation, named these three classes of devices:

1. Devices which modify engine operating conditions.
2. Devices which "treat" exhaust gases.
3. Use of modified or alternate fuels.

Technical Chairmen J. F. Snyder, Standard Oil Co. of Calif., Max Epps, General Petroleum Corp., and Wallace Linville, consultant to the Los Angeles County Air Pollution Control District, cooperated to bring three highly successful sessions to members and guests.

Assistant Field Editor R. S. Orchard
April 11

"YARDSTICKS" FOR A PREVENTIVE MAINTENANCE PROGRAM can be determined from the following five factors:

1. Routes travelled and road conditions
2. Weather and climatic conditions
3. Gross loads
4. Type and size of vehicles and type of power
5. Vehicle replacement procedures.

L. D. Conyers, Los Angeles shop manager, Consolidated Freightways, Inc., in explaining the application and operation of the preventive maintenance program in his organization, explained that **many people are needlessly frightened by the apparent complexity of such a system.** Actually, most fleet owners today have some form of preventive maintenance, although the size and nature of the particular operation may vary the procedure followed.

A simple record can be set up whereby a permanent record is kept on each vehicle. This, together with a job ticket specifying the work to be done, and the mechanic's time card will form the basis of the labor cost per mile or per hour of operation. Parts used can be applied against the job ticket number and thus a complete cost established.

In conclusion Conyers stated that the responsibility of management was to provide proper working conditions, and the most suitable equipment, and to initiate, underwrite, and enforce the entire preventive maintenance program; while it was the responsibility of the shop superintendent to organize the shop, train the staff, schedule the work, and evaluate the effectiveness of the preventive maintenance program.

Philadelphia

Field Editor G. T. Seng
April 13

BATTERIES CAN BE CONSERVED by the use of fibre glass reinforced plastic bodies on automobiles, because the plastic material is translucent, thus providing a pleasing diffused light inside the body, reducing the use of body lights.

This was stated by Walter R. Herfurth, assistant to the vice-president, Automotive Design Engineering, United Parcel Service, as one of the definite advantages of the new plastic bodies.

As opening speaker in a two man symposium on plastic bodies, Herfurth told members that **reduced fuel consumption and tire wear** are realized. Driver efficiency is also increased. Flexibility and energy storing characteristics of the material reduces damage to fenders and body and necessary repairs of this nature are easily made in a short time.

Speaking for plastics in the trailer body field, Stanley S. Wulc, Plastic Division, Strick Co., said that the good insulating characteristics of the material make possible short hauls of refrigerated goods without cooling equipment. The structural qualities are good and the bodies are easier to clean, thus reducing accumulation of harmful bacteria. The fact that a body of this type does not absorb and store odors and that the **material is non-corrosive** are definite advantages.

St. Louis

Field Editor Gene Kropf
April 12

YOU ARE ACTUALLY RIDING ON AIR, said Don J. LaBelle, engineer in charge of vehicle structure and suspension development, GMC Truck and Coach Division.

Speaking on the subject, "Air Suspension," LaBelle traced the development of this new concept of suspension that has come about through General Motors. Explaining the shortcomings of present

methods of suspension, he went on to show how air suspension is being utilized to give **not only a better ride for the passenger, but also cut operating costs and materially increased life for the vehicle.**

Laboratory tests and actual use of the system have indicated that most of the disadvantages of other suspension methods are overcome in "air suspension" and after twelve years of development, General Motors believes they have accomplished the objectives of improved comfort and decreased maintenance on motor coaches.

Southern New England

Field Editor A. D. Nichols
April 21

KEEPING THE ENGINE TUNED TO GET THE UTMOST IN PERFORMANCE AND ECONOMY FROM HIS CAR is the chief objective of a sports car owner. Owning and driving a sports car is a hobby to many men just as golf is. These were explanations of "Why is a Sports Car," the topic of David R. Allen, public relations director, Sports Car Club of America, Inc.

This was a joint meeting at Yale University with the newly formed Yale SAE Student Branch. Chairman of the Branch, Richard L. Kline, was technical chairman for the evening.

Following Allen's talk came a sound color film of the 1954 LeMans Race.

Mohawk-Hudson

Field Editor J. B. James
March 8

THE PETROLEUM INDUSTRY'S "MAGIC BARREL" pours forth paints, plastics, roofing, and refrigerants, but four of the many products. Allen P. Calvert added to this list dusting compounds for fruit trees, live stock insecticides, soil chemicals, dyes for synthetics, and plastic sheeting that is plyable below −40 F.

Especially notable, said Calvert, of the Oil Industry Information Committee of the American Petroleum Institute, is the **noninflammable refrigerant** "Freon 12." It is used as a propellant in hand operated dispensers for fluid or lather.

Cellophane is also a petro-chemical product. The variety of products are expected to pour forth from the "Magic Barrel" in mushrooming quantities in the years ahead.

April 12

OVER 2800 U. S. PATENTS HAVE BEEN TAKEN ON AUTOMOTIVE SPARK PLUGS, despite their seeming simplicity. To aid in the development of today's plugs, the following four techniques are employed:

1. Cycling temperatures of various parts of the plug are measured with platinum-rhodium thermocouples.
2. A misfire detector is used that can indicate a single misfire at 3000 rpm.
3. A shunt resistance meter is used (1 megohm is generally the threshold of misfire.)
4. A preignition detector is used.

"New Techniques to Match Spark Plugs to Engines" were presented by Richard C. Teasel, research engineer, Champion Co. He described the recent development of the new 18mm "Turbo-Action" plug, original equipment on 1955 Ford products.

Operating conditions are becoming more severe with today's higher compression ratio, rpm, vacuum and bmep. The "atmosphere" varies from 0 to over 4000 F and the plug itself normally operates from 300 to 1200 F through a speed range of 10 to 70 mph.

The new 18mm "Turbo-Action" plug has made possible an **extended operating temperature range,** providing a hotter plug at low speed through insulator modification and a colder plug at high speed through a larger "breathing volume" surrounding the insulator.

Salt Lake

Field Editor C. W. Dunbar
April 11

A NEW GENERAL MOTORS TRAINING CENTER is now nearing completion at Salt Lake City. Ray E. Waldron, manager of the Center, described the equipment, techniques, and objectives to be utilized in the training program. The Center expects to initiate its first training period for dealer service personnel from the area this spring.

Following this interesting talk, two very new films of test flights of experimental aircraft developed by Consolidated-Vultee Aircraft Co. were shown. The **Vertical Take-Off Airplane,** containing a turboprop powerplant, permits landing and take-offs from very limited areas and indicates a **high utility factor** as a carrier-based or ground-support weapon. The **Convair Delta Wing** jet aircraft was designed primarily for the interceptor role with the characteristics of **speed and maneuverability** combined with the stability of an effective "gunnery platform."

Brief comments on the characteristics of these aircraft were made by Prof. W. P. Barnes of the University of Utah.

May 9

ONE-THIRD OF THE AIR CONSUMED BY THE AXIAL FLOW JET ENGINE IS ACTUALLY BURNED IN THE COMBUSTION PROCESS and the rest provides the engine coolant.

Val B. Dean, sales engineer for Westinghouse Electric Corp., discussed the jet engines Westinghouse has developed. Reviewing the developments since the first axial flow jet engine, **the Westinghouse J-34,** he pointed out the greater simplicity in operating the jet as compared to the reciprocating engine. He cited examples from his own experience as a Navy jet pilot.

To supplement his talk, Dean presented the films, "Faster Than You Think," the story of his company's jet engine development, and "Dawn's Early Light," peacetime applications of atomic energy.

Propulsion Day
CONTINUED FROM PAGE 67

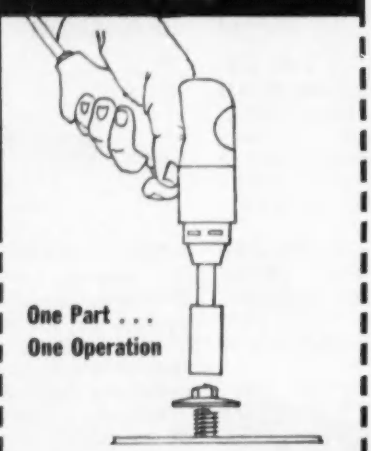
Fragility Rating

The "fragility rating" defines the largest magnitude of likely accidents and their nature which a device can tolerate without impairing its usefulness.

It consists of two numbers. The second is the one or more resonance frequencies of the device in the 5–75 cps transportation vibration range. The first is the maximum number of g's the device can stand in a test consisting of 10 shocks in each of three mutually perpendicular planes, plus 10 shocks in one or more other directions to be chosen by the design engineer—all shocks to be applied at the resonant frequency.
. . . **W. H. Skidmore, Weston Electrical Instrument Corp.**, "Fragility Rating"

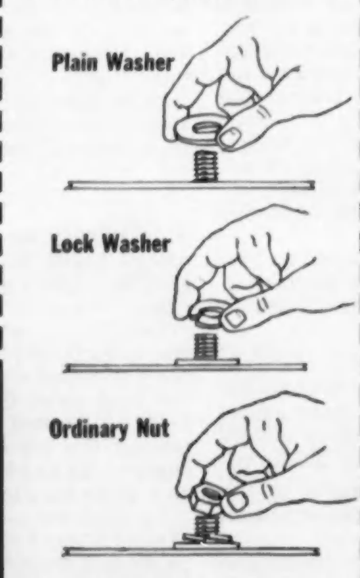
SPEED UP ASSEMBLY of Mouldings, Nameplates, Medallions, etc.

THIS



INSTEAD OF THIS

3 Parts . . . 3 Operations



REAL SAVINGS when Washer Type PALNUTS are applied to your mouldings, nameplates, medallions, deck handles, tail and parking lights, instrument mountings, etc. Also real security, due to live spring locking action. Popular thread sizes always in stock. State thread size and washer diameter or clearance around stud or bolt when requesting free samples.

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Cushion Design

Container Laboratories, Inc. has developed a cushioning nomogram for the Naval Bureau of Ordnance which will: (1) estimate the minimum possible thickness of cushioning material, (2) determine the required thickness of a given cushioning material, (3) help select a material which will provide a cushion of least thickness, or (4) indicate the bearing area that results in a cushion of least thickness of a given material.
. . . **H. E. Nietsch, Robinson Aviation, Inc.**, "Cushion Design from Fragility Rating"

Package Design

Package design should start as soon as physical dimensions of the unit are finalized. Then the two can be evaluated together. Development and testing of the packaging should continue until tests show that it will protect the unit against reasonable shock loads and against coincidence of impulse frequencies with natural frequencies.
. . . **John Cammarata** and **Vincent Atalese, Arma Corp.**, "Development of Shock and Vibration Test Methods for Packaging"

Flexible Suspensions

By mathematical analysis, it's possible to select the proper mountings for the flexible suspension of a particular piece of equipment in its container and to determine the correct locations for the mountings. Mountings and dampers can thus be arranged to limit the shock forces acting on the equipment to values it can safely stand.
. . . **J. J. Goodill, Lord Mfg. Co.**, "Flexible Suspension Systems for Equipment in Transit"

Missile Container

In one successful missile container Chrysler has designed, steel coil springs are the suspension medium. They give axial, vertical, and lateral protection in transit. The total system has a low natural frequency to isolate the missile from as many in-transit vibratory conditions as possible.

As an added precaution, the suspension includes constant-friction coulomb-type dampers.
. . . **R. L. Wiltse, Chrysler Corp.**, "Practical Development of Suspension Cushioning for a Guided Missile"

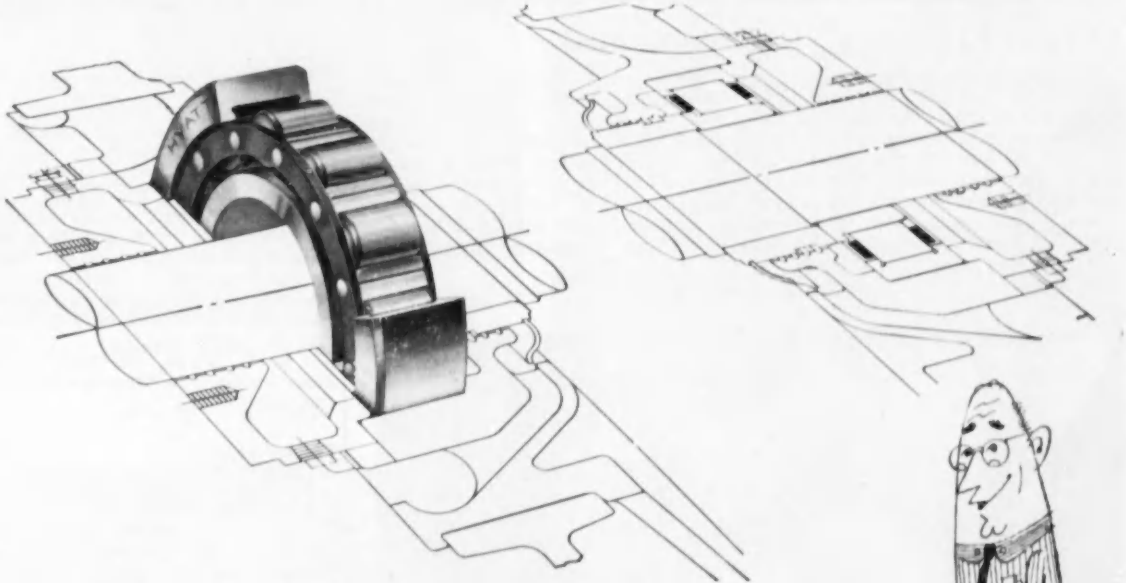
Few Shocks in the Air

The ride recorder proves that airplanes don't cause shock damage to shipments of ordinary air cargo items. If a unit is packaged well enough to withstand normal handling impacts, it will withstand any vibration encountered on the aircraft.

Ground handling is the area where greatest improvement can be made.

How Hy-Loads can help you . . .

OVERCOME OVERLOADING



HY POTENUSE, the sage of the slide rule, says:

This HYATT Hy-Load is heading for a long hard life. It's been designed into as tough a job as you can hand any bearing—the armature shaft of a steel mill motor.

These HYATT Bearings must maintain the armature on centers with very close running clearance despite the fact that *steel mill motors are frequently overloaded and are regularly reversed under full load!*

But ability to "take it" isn't the only reason leading motor builders mount HYATTS on both ends of armature shafts: the offset of the flanged inner race provides vital *inbuilt, non-adjustable free end float*, permitting the armature to center itself electrically. What's more, HYATT'S *separable and interchangeable* races facilitate quick replacement of armatures.

See why so many smart designers agree? *You can't go awry when you specify—*

YOUR COMPLETE LINE OF CYLINDRICAL ROLLER BEARINGS

HYATT ROLLER BEARINGS

STRAIGHT **BARREL** **TAPER**

HYATT BEARINGS DIVISION • GENERAL MOTORS CORPORATION • HARRISON, NEW JERSEY

You can't legislate careful handling—but you can educate people to it, we find.
. . . **A. C. Botsford, American Airlines, Inc.**, "Air Cargo Shock Damage Experience in Handling and Shipping"

3.2 Versus 5.7 Cm Radar

The McGill University project on airborne weather radar stated that 3.2 cm radar was better for detecting distant targets with little or no intervening rainfall but 5.7 cm radar could bettter penetrate heavier intervening rainfall and "see" targets beyond the rainfall area with less distortion. Thus, for best "penetration" 5.7 cm radar was recommended. This is the wavelength TWA chose for radar units installed in its Constellations.
. . . **R. N. White, Trans World Airlines, Inc.**, "Weather Radar Installation in TWA Constellations"

Isoecho Radar

Bendix's new airborne weather radar incorporates isoecho circuitry to display a contour of storm intensity. Outer edge of the white area of a rain return defines the rainfall rate at which echos are visible on the radar—near zero rain. Outer edge of the black hole in the center outlines the area within which the rainfall rate is greater than this by a pre-set amount. Therefore, where the white line between the no-rain area and the heavy-rain area is thinnest, the greatest turbulence will be found.
. . . **G. W. Church, Bendix Radio**, "A New Airborne Weather Radar"

Clear-Air Turbulence

At the edge of jet streams, there's often turbulence even though the air is clear. This high-altitude roughness is not so frequent nor so severe as that at lower altitudes. But it is significant because pilots can't see the high-altitude roughness. Therefore they penetrate it at high-speed cruise. The resulting forces on a plane during its lifetime are numerous enough and strong enough to warrant consideration in fatigue analysis.
. . . **R. D. Roche, Lockheed Aircraft Corp.**, "The Jet Stream: Sky-High Overdrive"

Flying High

At very high altitudes, the sun's rays become more intense and contain a higher proportion of ultraviolet light. The sky becomes darker, and there is less haze.

However, as sunlit areas become more glaring, shadows and shaded areas of the cockpit become darker. It's harder to read instruments, especially if they have glare shields. The solution may be artificial lighting of instruments or shaded sunglasses.
. . . **Dr. Ross A. McFarland, Harvard School of Public Health**, "Human Problems in Jet Air Transportation"

Accident Records

Accident records are and will probably remain one of the most valuable sources of safety design data. Facts—definite, glittering little gems of fact are what we must search out if the results are to serve the design engineer. One good way to display them is to array them on safety design check lists, Convair finds.
. . . **L. J. Bordelon, Convair**, "Safety Considerations in Aircraft Design"

Statistics of Rare Events

Aircraft engineers have long used statistical methods where the probabilities are large, such as the case of fires following crashes. But in aeronautics the probabilities are often very small. The gust that causes the pilot to lose control is a rare event.

These rare events can also be handled statistically by the Poisson distribution, NACA has shown. This method can determine, for example, the most probable maximum stress at any point in a structure. It can also reflect the effects of flaws resulting from manufacture.
. . . **Jerome Lederer, Flight Safety**

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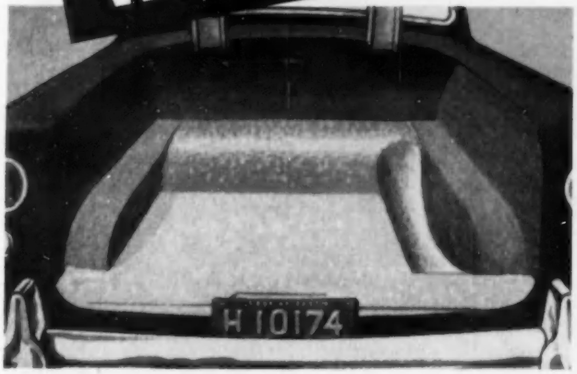
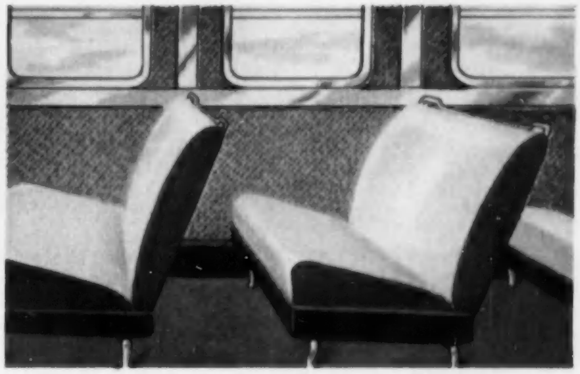
Marvibond

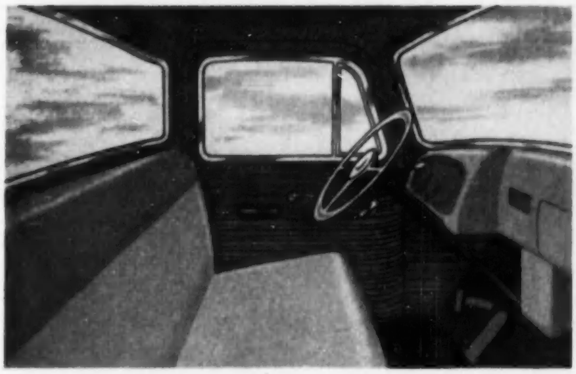
WHY NOT the new vinyl-to-metal laminating process



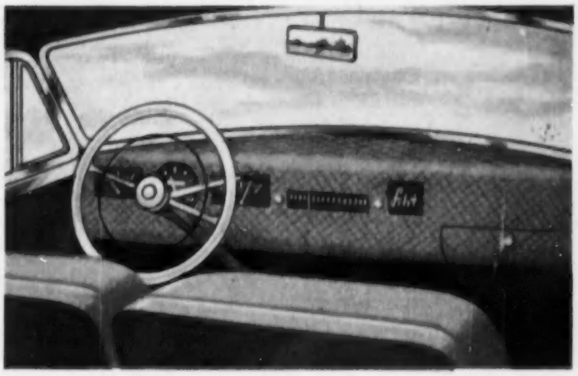
Trunk compartments? Marvibonded steel trunk compartments would protect luggage... be protected against luggage... be easily washed clean.



Bus interior linings? Marvibonded metal bus linings would resist "break-through"... would not scratch easily... would be low cost, low weight.



Truck cab interiors? Marvibonded steel truck cab interiors would be clean, comfortable, and easy to maintain... resist rust, oils, gasoline, road grime, and most chemicals.



Dashboards and interior trim? Marvibonded metal dashboards and interior trim would be richly attractive... glare-free... always pleasant to the touch.

WHY NOT MARVIBOND where beauty, permanence, and relatively low cost can be a distinct advantage in *your* manufacturing operations? No special dies or drawing compounds are necessary. The Marvibond process bonds vinyl film or sheet to metal before your product is formed. Marvibond, the new vinyl-to-metal laminating process, gives sheet metal these advantages...

- **outstanding protection against rust and corrosion!**
- **lastingly beautiful surface effects!**
- **superior abrasion resistance!**
- **eliminates costly finishing operations!**

For product improvement, added sales impetus, and production economy, better investigate Marvibond* today. Simply write to the address below.

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Foundation, Inc., "Actuarial Approaches to Safety"

Cooperative Engineering

The best way to perform a function is not merely the cheapest but the simplest and the lightest. To insure simplicity and minimum weight penalty, men concerned with engines, airframe, and accessories for a particular design have to get together early in the planning stage. Committee action on preplanning saves time in getting started on the project, even if it takes us down the wrong path once in a while . . .

. . . from Round Table on The Challenge of Cooperative Engineering in the Jet Age—**F. W. Fink, Convair Division**, chairman

Air Transport Day

CONTINUED FROM PAGE 69

Future Air Transport

Over the next few decades the speed spectrum will spread. Soon we'll have jet transports in the high subsonic range, and eventually in the supersonic range. But helicopters will continue to cruise at a relatively leisurely 100–200 mph.

They'll gain in power, but the gain will go into increased lifting power. We may even see helicopters delivering prefabricated houses. Their load ceiling will be about 10,000 lb.

Throughout the coming years, increasing emphasis will go on communication and navigation aids to insure reliability of service and general safety.

. . . from Round Table on The Future of Air Transportation—**William Littlewood, American Airlines, Inc.**, chairman

T56 in Convair 340

USAF tests of an Allison T56 engine installed in a Convair 340 airliner show that the turboprop improves performance considerably. Take-off distance for the turboprop version to clear a 50-ft obstacle is 1680 ft, as compared to 2130 ft for the standard piston-engine version. Climb performance of the turboprop aircraft is from two to three times as good, and cruising speed is from 15 to 30% better than with piston engines. At 47,000 lb gross take-off weight, the turbine aircraft can maintain 35,000 ft on two engines and 20,000 ft on one.

. . . **Capt. R. D. Cousins, USAF**, "USAF Experience to Date with Turboprop Aircraft"

How the DC Series Began

On Aug. 2, 1932, Jack Frye of TWA sent one page of specifications for a new transport to Donald Douglas and asked how long it would take to build one such plane for service test.

It was this letter that stimulated the development of the DC-1. Only 11 months after it was received, the DC-1 made its first flight.

. . . **A. E. Raymond, Douglas Aircraft Co., Inc.**, "DC-1, 2, 3, 4, 5, 6, 7 . . . n"

Next Constellation

The Model 1649 Constellation is under development to provide east-west Atlantic crossings against winter winds without sacrifice of payload. The 1649 will have 12% more wing area, 33% increase in aspect ratio, and 46% greater fuel capacity than the 1049G. Each of the 1649's compound engines will deliver 3400 hp for take-off and have a METO rating of 2800 hp.

. . . **H. L. Hibbard and C. L. Johnson, Lockheed Aircraft Corp.**, "Life and Times of the Constellation"

Viscount is Quiet

We've found that the internal noise level of the Viscount is quite low. It seems even better than it is because of the small amount of vibration. As in any propeller-driven airplane, noise and vibration levels are higher near the plane of the propellers.

External noise level is lower and of a different type from that of most piston-engine aircraft.

. . . **J. T. Dyment, Trans-Canada Air Lines**, "The Vickers' Viscount on Trans-Canada Air Lines' Routes"

Military Aviation Day

CONTINUED FROM PAGE 71

'Copters Lay Wire

Marine helicopters equipped with a special high-speed wire dispenser can fly across country, placing telephone wire on the tops of trees. Atop the trees the wire is safe from cutting by tracks and wheels of military vehicles. If trouble does develop, the helicopter lays a new line and reels in the old.

. . . **Col. K. B. McCutcheon, USMC**, "Marine Corps Assault Aircraft Transports"

'Copter Turbines

Comparison of free and fixed turbine engines for helicopters shows that for a 10% rotor speed decrease, the free turbine loses 4% hp and the fixed turbine loses 15%. The free turbine requires rotor accelerations with their attendant problems for thrust modulation, whereas the fixed turbine can operate as a constant-speed machine. Overspeed and over-temperature prob-

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–and without special installation tooling!
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Both designs obsolete other chrome-plated multiple-piece oil rings because only Muskegon's patented "Unitizing" process provides such unique time and money saving benefits. This process holds the pieces together, in the right order during installation, with a special adhesive. The adhesive dissolves completely during the first engine run. The tough, gleaming chrome-plated rails virtually eliminate scuffing, reduce engine rejects, increase oil economy.
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First of Muskegon's famous "Unitized" chrome-plated multiple-piece rings . . . proved on America's greatest production lines and in the finest cars. Rails and spacer are correctly pre-assembled and "Unitized" to handle like a one-piece ring.
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Claims are easy to make, but putting a savings guarantee in writing is something else again. Controlled "T" chilled iron shot and grit have been engineered to overcome the undesirable characteristics of chilled iron abrasives: You get longer life, because of a ductile matrix; lower maintenance costs, because of controlled lower BHN; yet all the speed and cleaning efficiency you need. A 15% savings over your present abrasive costs guaranteed in writing or you get a check to give you the guaranteed savings. Make the test without upsetting your routine: ask about the "electric timing device."

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lems are more severe for the free turbine.
. . . **W. S. Miller, Jr., R. P. Krebs, and T. C. Blaschke, NACA,** "Shaft Gas Turbines for Helicopters"

'Copter Future

By 1965, helicopters will annually carry 29 million revenue passengers on under-100-mile trips, 15 million on 101–250-mile trips, and 6 million on 251–500-mile trips. Initially, fares will range between 8 and 10¢ per mile. Later they will decline to 6 or 7¢ per mile.
. . . **G. H. Aldrich, Air Transport Association of America,** "Helicopter Horizons"

Engine Qualification

The differences between American and British engine qualification practices seem to stem from this fact: U. S. manufacturers have almost unlimited wind tunnels and other equipment for testing components. The British do not. Consequently U. S. manufacturers type-test a first production-line engine. British manufacturers type-test a prototype engine.

Therefore, in evaluating the results, Americans look for minute weaknesses while the British are more interested in the proof of their design. . .
. . . from Round Table on American and Foreign Practices of Engine Design and Qualification—**J. D. Redding, Westinghouse Electric Corp.,** chairman

Tactical Suitability

The tactical suitability of an aircraft powerplant includes its reliability, durability, and maintainability, as well as its performance suitability.

To these ends, an engine must be convenient to install, have a minimum number of connections to the airframe, be easy to assemble and disassemble, and require few special tools. What's more, components should be uniform to the extent that there is no need for matching in the field. . .
. . . from Round Table on Tactical Suitability of Aircraft Powerplants—**Col. Norman Appold, USAF,** chairman

Missile Reliability

Extreme environmental conditions cause the most reliability trouble, as expected. But you can't be sure just because the extremes are troublefree that the moderate range will be satisfactory. You have to study the whole range.

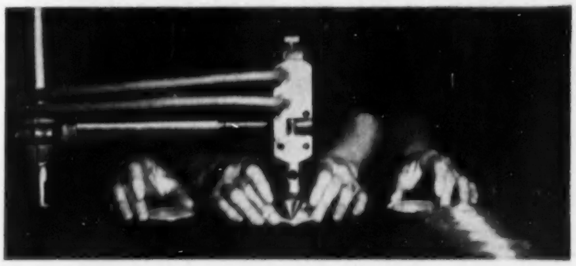
When we're depressed about the effect of successive component reliabilities on total missile reliability, it helps to remember the complementary effect of multiple missiles. Three missiles at 50% reliability give 87% assurance of success. Four missiles give 94% assurance.
. . . **C. C. Ross, H. A. Eubank, and R. C. Stiff, Aerojet-General Corp.,** "Some Aspects of Guided Missile Powerplant Reliability Requirements"

NOW! DAREX *Flowed-in* GASKETS

for OIL FILTERS and AIR CLEANERS

↑ *A section of the Dewey and Almy laboratories where* DAREX *"Flowed-in" gaskets for oil filters have been tested to specification: 100 hours at 280°F under 40 lbs. pressure using S.A.E. 20 oil.*

↓ **THE "FLOWED-IN" WAY.** *With a* DAREX *semi-automatic machine, there are only two hand motions. Operator feeds with one hand, clears with the other.*



THE SAVINGS in labor and materials that DAREX "Flowed-in" gaskets have brought to other automotive parts are now available to manufacturers of oil filters and air cleaners.

Dewey and Almy development engineers have made an exhaustive study into the problems of gasketing these products. The results, which are available to you for the asking, indicate that DAREX "Flowed-in" gaskets cut deeply into the cost of hand assembly.

Here's why the "Flowed-in" process cuts costs

The amazingly-simple "Flowed-in" process eliminates the excessive time, motions and money required in hand assembly of gaskets to the lids of oil filters and air cleaners. In the "Flowed-in" process, the lids are revolved automatically while a uniform circular track of liquid gasket material is deposited where needed. Baking or drying transforms the fluid into a rubbery gasket that adheres to the lid. You save — in labor, by eliminating hand assembly — in materials, by eliminating waste and improving quality.

Dewey and Almy provides everything you need to take advantage of these savings: tested gasketing compounds, application equipment, more than 30 years of research and engineering experience. Let us show you specifically what your savings will be from the DAREX "Flowed-in" gasket process! Phone, wire or mail the coupon *today!*

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Twin Disc Power Take-Offs are available with clutches ranging from 6.5" to 24" single-plate; from 11.5" to 24" double-plate. Housing sizes No. 6 SAE to No. 00 SAE. Capacities up to 600 hp. Write for Bulletin No. 129-C.

POWER
TAKE-OFF

Next time you're watching powered equipment driving through a friction power take-off, check the name plate on the drive back of the engine. In all probability, you'll see a Twin Disc Power Take-Off, putting *more horsepower to work.* With their simple, *rugged* design—single-point adjustment—and slippage capacity far in *excess* of horsepower rating, *Twin Disc Power Take-Offs are selected as standard equipment by most of the nation's leading industrial engine manufacturers.*

That's why you'll find Twin Disc Power Take-Offs on such leading industrial engines as Ajax - Buda - Caterpillar - Climax - Continental - Cummins - Hercules - International - Le Roi - Minneapolis-Moline - Murphy - Superior - Waukesha - White - Wisconsin . . . for these manufacturers know they can depend on Twin Disc performance . . . and they know, too, that wherever their engines may be ultimately working, Twin Disc Service will only be a matter of hours . . . backed by 60 Parts Stations and 8 Factory Branches or Sales Eng. Offices.

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TWIN DISC CLUTCH COMPANY, Racine, Wisconsin • HYDRAULIC DIVISION, Rockford, Illinois

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CONTINUED FROM PAGE 83

• AMS 7472E—Bolts and Screws, Steel, Corrosion Resistant, Roll Threaded;

• AMS 7476A—Bolts and Screws, Steel, Corrosion and Heat Resistant, Roll Threaded;

• AMS 7478A—Bolts and Screws, Steel, Corrosion and Heat Resistant, Heat Treated—Roll Threaded;

• AMS 7479—Bolts and Screws, Steel, Corrosion and Heat Resistant, Heat Treated—Roll Threaded, 1650 F Heat Treatment;

• AMS———Titanium Alloy, 3A1—5Cr;

• AMS———Titanium Alloy Sheet, 5A1—2.5Sn, Annealed—110,000 psi Yield;

• AMS———Solid Film Dry Lubricant Coatings.

New Lighting Panel Committee Formed

THE Special Aircraft Projects Division of the SAE Aeronautics Committee has set up a new committee (S-10) on Plastic Lighting Panels and Dials. This group will identify and consider engineering problems of producers, users, and government agencies concerned with plastic lighting panels, dials, and lighted instruments where these problems require joint action. Among the activities contemplated are:

1. Development of criteria for design and performance.
2. Development of production tolerance and allowance criteria.
3. Development of testing and inspection criteria.
4. Formulation of new standards, specifications, recommended practices and procedures where the need is indicated.
5. Coordination and distribution of related information.

At the first organization meeting of this committee, which was held in New York City, March 23, 1955, the following men were elected to a Steering Committee:

J. G. Hoffman, Bodnar Industries, Inc.
W. C. Fisher, USN Bureau of Aeronautics
W. Kes, Hazeltine Electronics Corp.
T. O. Twist, US Bureau of Standards
Charles Milliken, Lockheed Aircraft Corp.
R. K. Davis, Wright Air Development Center
Dale Lawrence, Boeing Airplane Co. (alternate)
E. A. Neugass, Plasteck, Inc. (alternate)
Dan Kaufman, Bendix Radio Division, Bendix Aircraft Corp. (alternate)

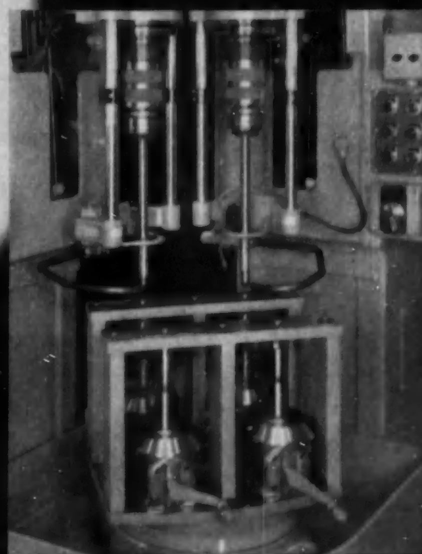
The man who needs a new machine tool and doesn't buy it is paying for it anyway... — in scrap losses

Age alone doesn't obsolete machines. There are other factors. Consider the closer tolerances of two- or three-tenths now being demanded on the production line. Many a machine tool installed only five years ago can't hold to these precision tolerances. Any attempt to do so results in high scrap losses.

Consider the design of the machine. Today there is less dependence on the skill of the operator. Less subjection to human inconsistency. The built-in controls on machines utilizing the latest processing techniques minimize the problem of rejected parts.

One process with which industry obtains precision-production is Microhoning. This low-velocity abrading technique, employing low speeds and removing stock over a wide area, produces parts to exact dimensional and geometric accuracy. Microhoning uses a self-aligning tool with self-sharpening abrasives. There are no chucks to wear out of alignment; no off-tolerance parts because of dull tools or abrasive wheels needing dressing.

Check your scrap losses. Then decide whether you can afford to keep machine tools that cannot produce to current precision-production standards. You may discover that the money your scrap is costing you would buy a new Microhoning machine.



PART:
Shaft, Convertor Reactor

PROBLEM:
Flame hardening caused shaft to bow, resulting in a high scrap rate.

SOLUTION:
Microhoning — removed from .004" to .006" stock from the diameter, generated a straight, round bore and eliminated scrapping of parts.

MICROHONING = STOCK REMOVAL + GEOMETRY + SIZE CONTROL + SURFACE FINISH

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REPRESENTATIVES IN ALL PRINCIPAL COUNTRIES

MICRO-PRECISION DIVISION = 2205 Lee Street, Evanston, Illinois
Hydraulic controls • Diesel fuel injection equipment

Visit Booth 1211 at the Show. See other examples of how Microhoning can reduce scrap losses.

THE MACHINE TOOL SHOW
CHICAGO, ILL.

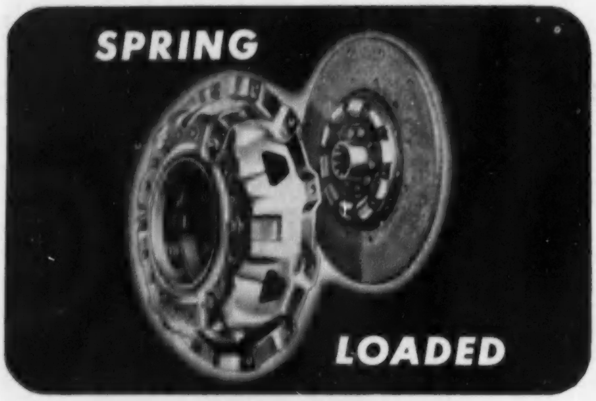
About SAE Members

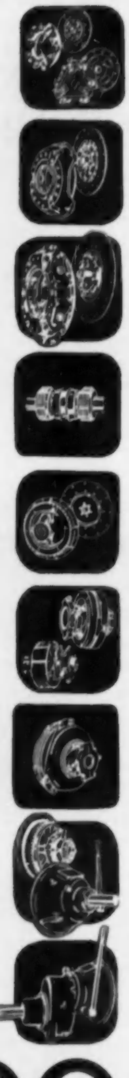
CONTINUED FROM PAGE 91

WAYNE H. McGLADE, factory superintendent of the Adams Division of LeTourneau-Westinghouse Co., Indianapolis, Ind., has been transferred to LeTourneau-Westinghouse Co., Peoria, Ill. In his new capacity he is assistant to the executive vice-president.

DR. RAY P. DINSMORE, vice-president of research and development of Goodyear Tire and Rubber Co., spoke at the May meeting of the American Institute of Chemical Engineers on "The Professional Engineer and the Public." He is a director of the Institute.

ROCKFORD





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HEAT DISSIPATION
LIFETIME ADJUSTMENT

* The cushioning spring arrangement between the facings in ROCKFORD Spring Loaded CLUTCHES provides cushioned engagement that enables smooth pick-up of the load, without grabbing or chattering. The springs maintain ample pressure to assure the required torque.

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ROCKFORD CLUTCH DIVISION BORG-WARNER
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CLUTCHES

GEORGE M. SCHUEDER has been appointed works manager in charge of production and engineering at Evans Products Co., Plymouth, Mich. He joined the company 18 years ago as a project engineer and has been chief engineer for the past nine years.

W. V. KERSHOW, who has been with Willys Motors, Inc. almost continuously since 1913, has been named general service manager. He has been serving as technical service manager.

CHARLES PONTI is now fleet maintenance coordinator with the Warner Co. of Philadelphia, Pa. He was formerly with Yellow Rental, Inc. in the capacity of general superintendent of maintenance.

JULIUS R. KOPPELMAN, formerly engineering designer with Ryan Aeronautical Co., San Diego, has taken the position of design draftsman with Emerson Electric Mfg. Co., St. Louis.

FRANK W. QUIGGIN has joined the Cooper-Bessemer Corp., Mount Vernon, Ohio as sales engineer. He had been assistant to the vice-president of sales with Read Standard Corp. of New York City.

HERBERT CHAMBERS has been appointed supervisor of a development group of Consolidated Engineering Corp. He had been supervisor of new product development for Electric Auto-Lite Co.

CARLOS D. KELLY has announced his resignation as vice-president in charge of sales for Purolator Products, Inc., manufacturer of automotive oil filters and other filtration equipment, Rahway, N. J.

TED DEL SOLAR has taken a position with LeTourneau-Westinghouse Co. as an equipment test engineer. He has been automotive technical writer with the U. S. Army, Ordnance Automotive School, Atlanta, Ga.

SAE JOURNAL would very much like to print your job promotion, change of company affiliation, or professional recognition or awards you may receive.

Please address any such items to:

News Editor
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A new era in the art of forging has been established as production goes forward on this 35,000-ton closed die forging press. Larger forgings with closer tolerances than heretofore possible open new concepts in forging design. Wyman-Gordon continues to pioneer by—*Keeping Ahead of Progress.*

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Mountains Moved ...Money Saved

International Truck, Model RF-174

Universal joints really get a workout in the "off highway" heavy construction field. Nothing's rougher than transmitting torque while moving mountains of material over washboard roads.

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That's why Borg-Warner engineers at B-W's Mechanics Universal Joint Division eliminated 28 pounds of dead weight . . . made their universal-shaft assemblies 34% lighter . . . without sacrificing quality, accurate balance or smooth operation. And that's why these Mechanics precision-fitted, roller bearing joints "keep 'em rolling" with little likelihood of expensive, work-stopping repairs.

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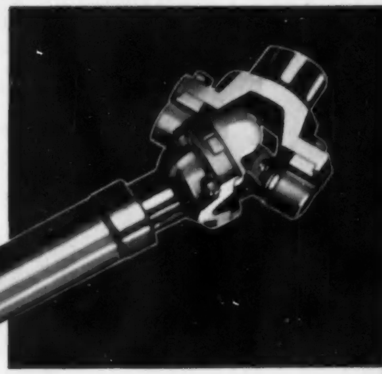
This substantial saving is another direct result of Borg-Warner's tradition: "Design It Better—Make It Better" . . . an active policy serving the automotive industry every day with scores of precision parts.



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Piper's Apache Has Low Wing Design

Based on paper by
WALTER C. JAMOUNEAU
Piper Aircraft Co.

TO provide maximum utility, the rear seat of the twin-engined Apache is designed for ready removal so that the entire cabin to the rear of the front seats can be used as a cargo department. The structure in the aft section of the cabin is located below the floor to provide maximum usefulness.

The cruising speed is over 160 mph at 8000 ft at 65% power, and the top speed is slightly above 180 mph at sea level. With constant speed propellers a range of manifold pressure settings and rpm is available so the pilot may select the combination providing the best speed, least noise, and smoothest operation.

Gross weight is 3500 lb and the custom model, including gyroscopic instruments and both communication and navigation radios, has a 2200-lb empty weight. At gross weight with fuel and oil and four persons aboard, the custom model has an allowance of 158 lb for baggage or additional equipment.

At gross weight, with critical engine (port) out, it is possible to get a sea level climb of 230 fpm and a ceiling of 6750 ft. Ceiling improves about 400 ft for each 100 lb reduction below gross weight. (Paper "Development of the Piper Twin Engine Apache" was presented at SAE Wichita Section, Nov. 13, 1954. It is available in full in multilith form from SAE Special Publications Department. Price: 35¢ to members, 60¢ to nonmembers.)

Friction Materials Face New Demands

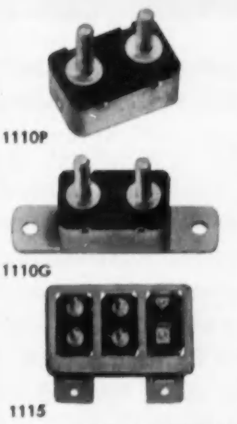
Based on paper by
DON ROHRER
Gray-Rock Division,
Raybestos-Manhattan, Inc.

HIGHER SPEEDS, less room for conventional brakes because of tires, and the elimination of engine braking due to automatic transmissions, all mean more work to be done by the brake. Power brakes, for example, help the driver by reducing necessary pedal pressure, but they do not add to brake capacity, make the brakes more heat resistant, or lengthen brake lining life.

Among recent developments in the field of friction materials may be mentioned bonded brake linings which are apparently here to stay. The bonding of the lining to the shoes is presumed to add greatly to lining mileage, due to the increased area of lining (no rivet holes) and the increased thickness available for wear. However, the better mileage does not always materialize because of such varied reasons as: poor adjustment, noise, grease or brake fluid on the lining, or erratic action. Bonded linings are generally noisier than riveted ones.

Several manufacturers of larger cars have cut a ½ in. wide groove down the center of the lining. The purpose is obviously to remove the "hot spot" in the lining and help to eliminate brake fade and hard pedal. According to reports it is effective.

Thus far only one U. S. car model has had disc brakes. The brake is costly and particularly expensive to reline. Work continues, however, and the English Lockheed and Girling


FASCO
AUTOMATIC RESET
CIRCUIT BREAKERS


STOP TROUBLE BEFORE IT STARTS!
Instantly . . . automatically . . . without fail . . . these Fasco products protect electrical circuits from overloads and shorts . . . safeguard the operation of low-voltage electrical equipment. Available in 8, 10, 15, 20, 25 or 30 ampere capacities . . . for mounting in 1, 2, 3, 4 or 8-unit FASCO brackets.
When it comes to circuit breakers, the automotive industry has found that it pays to CONSULT FASCO . . . FIRST!
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ROCHESTER 2, NEW YORK
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brakes seem to be more effective and practical.

Bonded clutch facings have been used in truck and bus applications. They can be bonded only to flat plates, hence they are impractical for passenger cars with their cushion plates. Recent tests indicate that bonded facings do not have the life expectancy of riveted facings, perhaps because of the rigidity and the insulative effect of the bonding element.

Materials marketed for application to surfaces of brake linings or clutch facings to improve friction and lengthen friction material life, have been carefully tested and found not only to be useless but sometimes dangerous.

Ceramic friction materials with their higher heat resistant ingredients are effective on airplane brakes or others where high temperatures are reached. They may well be the coming friction material. (Paper "Friction Materials" was presented at SAE Cincinnati Section, Cincinnati, March 22, 1954. It is available in full in multilith form from SAE Special Publications Department. Price: 35¢ to members; 60¢ to nonmembers.)

Public Calls The Style Shots

Based on paper by

MARSDEN THOMPSON

General Motors Corp.

BEFORE a car is put into production today, it is exhibited at shows and a thorough study is made to find out how people feel about it. Trained interviewers are used and their findings are tabulated to provide a statistical basis for deciding what's what. Some pre-production changes may be called for, or approval may be such that little if any change is needed.

Taking the public pulse does not mean that the public is expected to design our cars. It is up to the stylists, the engineers, and various other technical people to use their skills and specialized training to look ahead of the crowd and offer advancements which are beyond the conception of the layman. But the average car owner is an expert on use; he has strong ideas on what he likes and dislikes; and upon him ultimately depends the success or failure of our projected design. So the more we know about opinions, the better we are able to offer him the types of designs he will most likely want to buy. (Paper "Evaluating Automobile Styling" was presented at SAE Golden Anniversary Passenger Car, Body & Materials Meeting, Detroit, March 1, 1955. It is available in full in multilith form from SAE Special Publications Department. Price: 35¢ to members, 60¢ to nonmembers.)

It's Fewer Units And More Car Per Car

Based on paper by

W. B. HARRIS

Fortune Magazine

THE automobile industry is running full-speed into a new kind of market that may turn out to be more challenging than any it has encountered. The

Whether it's steering linkage parts for

a 1928 auto...

...for today's production models...

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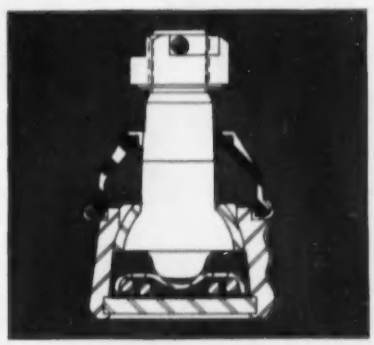
YES, manufacturers of automobiles, trucks, tractors and buses look to Thompson for a long list of dependable parts.

The Thompson Dual Bearing tie rod end is typical of Thompson Products' contribution to today's automobile. Among the many other Thompson products found on today's automobiles are the revolutionary new Thompson-engineered Ball Joints used in front wheel suspension and complete steering linkage units.

And typical of Thompson's dependability as a source of supply is the fact that Thompson is still manufacturing replacement steering linkage units for cars up to 27 years old.

Tomorrow's cars will use Thompson products, too, because automotive manufacturers have learned they can count on Thompson to develop and manufacture dependable parts. If you use steering linkage units, why not use "Steering Linkage by Thompson". For full details on how Thompson can help you with your steering linkage problems, write, wire or phone Thompson Products, Inc., Michigan Division, 7881 Conant Avenue, Detroit 11, Michigan, WA 1-5010.



A Tie Rod End ball stud should fit snug in the socket. Any tie rod end starts that way but the extra bearing surface in the Thompson Dual Bearing tie rod end keeps the stud snug in the socket far longer.

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market for cars as units seems to have passed the postwar peak and will probably settle, during the next few years, on a somewhat lower plateau. No new plateau is likely to be seen until the 1960's.

After reconsidering scrappage rates, household formation, and other factors that determine market, we believe that the industry's high estimate of 5,800,000 in 1955 is possible, but at this time it is hard to see that it is probable. For the 1955–59 market we see an average of five million units and an outside high of 5,700,000.

More by chance than by calculation the industry has been selling more car per car—more accessories, luxuries, improvements, and innovations—to get its share of the consumer's dollar. We believe the industry must now plan it that way. As unit sales tend to decline and level off while income is rising, the widening spread between unit demand and purchasing power will create a powerful drive to sell still more car per unit.

The question is what does the industry have coming to market in 1955 for 1956 that will attract the new car buyer's fancy. The answer to this new market problem will come principally from the men who make up this professional automotive group. (Paper "The Market for the Changing American Automobile" was presented at SAE Golden Anniversary Passenger Car, Body, and Materials Meeting, Detroit, March 3, 1955. It is available in full in multilith form from SAE Special Publications Department. Price: 35¢ to members, 60¢ to nonmembers.)

Dream Cars Have Wide-Awake Use

Based on paper by

D. C. WOODS

Ford Motor Co.

THERE are four practical reasons for the development of the test tube automobile or dream car as it has come to be called.

The first reason is market research. Dream cars provide an opportunity for testing consumer reaction to new and novel design features.

A second and very valuable purpose is to give stylists a chance to let their fancies fly free from the restrictions ordinarily imposed by production. Having soared a bit, the stylist can resume work on production models with more zest.

Management conditioning is the third purpose of the dream car. If management is shown styling planned for a later date, acceptance will be given more readily for having become accustomed to the change.

From the manufacturer's standpoint,


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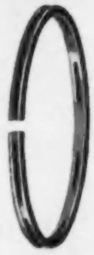

HD-20 Oil Control Ring

Sealed Power Engineered Piston Ring sets feature protective Granoseal Finish, which prevents scuffing and reduces friction 60%, by actual laboratory tests.

Actually, Granoseal Finish is a non-metallic manganese iron crystalline phosphate finish produced by surface conversion of the piston rings in the "Thermoil-Granodine" chemical bath.

TF-30 Compression Ring

RT-40 Oil Control Ring

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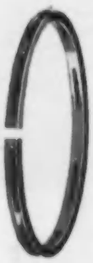

RT-20 Oil Control Ring

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the fourth and last reason is perhaps the most important. The nation-wide showing of cars sporting design innovations identifies the innovations with the company and makes competitors loath to use them. With enough dream cars exhibited in private shows, a company can blanket style features for years to come, and make competitive going difficult.

(Paper "Styling A Dream Car" was presented at SAE Golden Anniversary Passenger Car, Body & Materials Meeting, Detroit, March 1, 1955. It is available in full in multilith form from SAE Special Publications Department. Price: 35¢ to members, 60¢ to nonmembers.)

Probing for Factors In Steel Part Fatigue

Based on paper by

C. W. GADD
J. O. ANDERSON
DAVID MARTIN

Research Laboratories Division, GMC

Complete paper will appear in 1955 SAE Transactions

ONCE a laboratory fatigue program has been completed, the question arises to what degree results are applicable to actual field conditions and to what extent they can be extended to other members or structures.

Even when consideration is limited to steel parts there are many interrelated factors affecting the strength actually obtained. However, early in the development of a highly loaded part some kind of estimate of probable strength must be made and it is axiomatic that it be as sound as possible.

The reasoning upon which the strength estimate is based may be thought of as depending upon a number of basic factors. An important one is the nature of the service loading, particularly as to number of cycles and range of stress involved; another is the general type of steel. Fortunately, this may not be as basic as its hardness —which correlates well with tensile strength as well as to a reasonable degree with fatigue properties.

Still other factors which appear important are the range of stress and the sharpness of the stress gradient at the critical zone. The extent to which these or other factors are proved to be basic will govern the possibility of selecting, in a given practical case, the treatment most likely to succeed.

In general, range of stress appears to be an important factor having its greatest influence when it lies chiefly on the tensile side and when applied to parts of highest hardness. Fortunately, as born out by tests with a

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crankshaft, its influence appears to be relatively consistent through a range of material conditions.

Although postulated as having a basic influence upon endurance limit and the effectiveness of surface treatments, stress gradient has not yet been thoroughly explored. Since the true stress gradient near the surface often cannot be accurately obtained, it may be thought of in an approximate way as being proportional to notch radius in members having high concentration of stress. Looked at this way, the response in fatigue to surface treatments has appeared to follow stress gradient theory, but only distinctly in the realm of smallest fillet radii. Here large gains have been found from strengthening of only the very thin layer actually experiencing high service stress.

Normal or "par" value of endurance limit for a steel has been found to correlate better with hardness than other common physical tests. Indeed, in our studies through a range of soft- to medium-hardness steels it is seen that increase in fatigue strength is roughly proportional to increase in surface hardness reading.

(Paper "Some Factors Affecting the Fatigue Strength of Steel Members" was presented at SAE Golden Anniversary Annual Meeting, Detroit, Jan. 13, 1955. It is available in full in multilith form from SAE Special Publications Department. Price: 35¢ to members, 60¢ to nonmembers.)

Ideal Air Dilution Ratio Calculable for Ducted Fan

Based on paper by

ISRAEL KATZ

Cornell University

BY a generalized mathematical method, it's possible to calculate required air dilution ratio for a proposed ducted-fan turbine powerplant. The same analysis yields also the pressure ratio of the secondary air compressor and the expansion ratio of the turbine stages that drive the secondary air compressor, as well as temperatures and pressures all around the cycle.

The goal for the ducted fan—as for all powerplants that accelerate ambient air to develop propulsive thrust—is to achieve a jet discharge speed equal to twice the required flight speed. The key to this achievement is to secure proper dilution of the primary discharge by secondary air. Only with the optimum dilution is it possible to obtain economical operation without compromising propulsive efficiency.

The generalized analysis is useful as a first determination at the design point, prior to detailed cycle analysis.

(Paper describing the generalized analysis, "Optimum Flow Dilution in Ducted-Fan Engines," was presented by title at SAE Golden Anniversary Aeronautic Meeting, New York, April 18, 1955. It is available in full in multilith form from SAE Special Publications Department. Price: 35¢ to members; 60¢ to nonmembers.)

Aluminum Parts Forming Has Its Tricks

Based on paper by

DAVID E. BREHM

Cessna Aircraft Co

STRETCH PLUGS, used in the stretch forming of aluminum sheet metal parts, have been cast from Kirksite for production tools, and made of hydro stone for short life experimental tools. The metal plugs have to be cleaned up and polished so they will present a uniform smooth surface over the area contacted by the work piece. And this takes time.

Stretch dies are now being made by laminating the plaster pattern with an epoxy resin and glass cloth to a thickness of ¼ to ½ in., then filling with a core foam, and sealing. The lamination is made of two layers of fine woven cloth and one of coarse, and if the die is rather large, one additional layer of the fine. It is allowed to cure about 1 hr before core material is added.

It requires only 16 hr, for other than plaster work, to make a tool by this method. Little or no work is required on the finish surface, while repairs or minor changes can be made in very few hours. The costs are less than one-third that of Kirksite, and the product is much more accurate, as a rule.

Tools for draw forming are touchy. Contact surfaces of punch, die and blank holder must be well polished to reduce friction and assist the flow of metal. Punch clearance, alignment,

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- **Operation not affected by engine attitude.**

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hold down pressures, press speeds, and lubrication all influence the drawing and forming operation.

Alloys that work harden rapidly must be drawn at slow speeds. Some of the most common troubles met in drawing are: (1) Orange Peel—caused mainly by grain size of the metal being too large, portions of the work piece have not received enough cold work to recrystallize in annealing and flow resistance such as excessive blank holding pressure on sharp die radius. (2) Flange Wrinkles—usually attributable to blank holder surfaces not being parallel, insufficient blank holder pressures, or too much lubricant. (3) Wall Wrinkles, Step Rings, Draw Marks, and Fractures—all caused by fautly die, blank holder, blank holder pressure, lubricant, or know-how. Never give up on a draw forming job until you've studied every angle and tried several lubricants.

We have had parts that could not be drawn completely down in two operations and have used what could be called a "quick anneal operation". We dunk the part in salt bath 10 to 15 sec. quench blow the water off, and form about to the bottom of the die. Then we clean and run the complete heat-treat cycle before final draw. Parts so drawn have always passed laboratory pull tests and have never developed any trouble in the field.

Drop hammer forming is the one type where the operator must know the metal, the machine, where to use what rubber, how much and at what stage of the forming cycle.

Once wrinkles appear, they must be removed by hand or press planishing before going ahead with the hammer finishing operation. The technique of using plywood or steel draw rings and rubber pads to overcome the tendency to wrinkle and buckle are well known, but the sequence and placing of these aids must be worked out for each individual item. We photograph the set-up for reference to prevent loss on set-up of subsequent runs. We use 50 to 55 Durometer rubber in 1/16 to 1 in. thickness, and semi-cured rubber at our drop hammers. We seldom use lubricant.

(Paper "Forming Aluminum Sheet Metal Parts" was presented at SAE Wichita Section, Nov. 13, 1954. It is available in full in mutilith form from SAE Special Publications Department. Price: 35¢ to members, 60¢ to nonmembers.)

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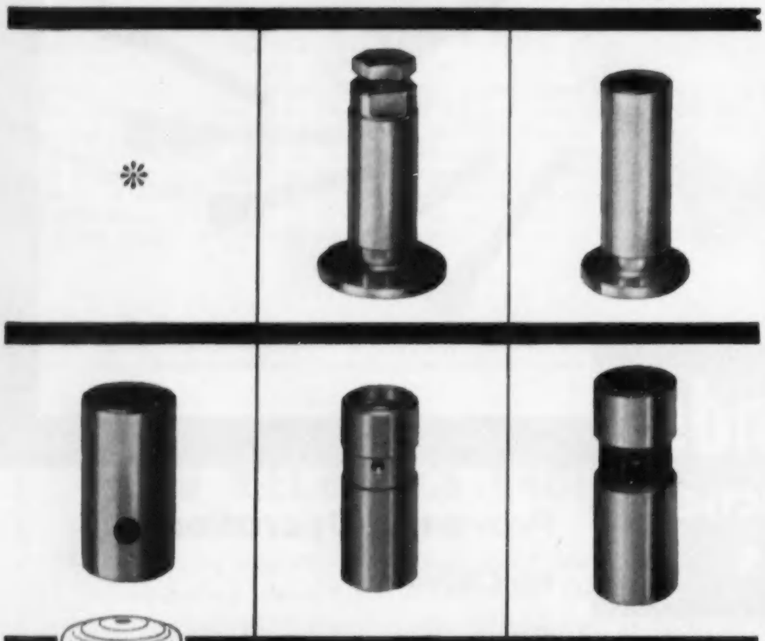

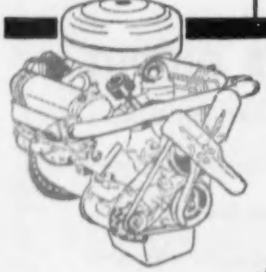

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Choosing Propellers For Utility Airplanes

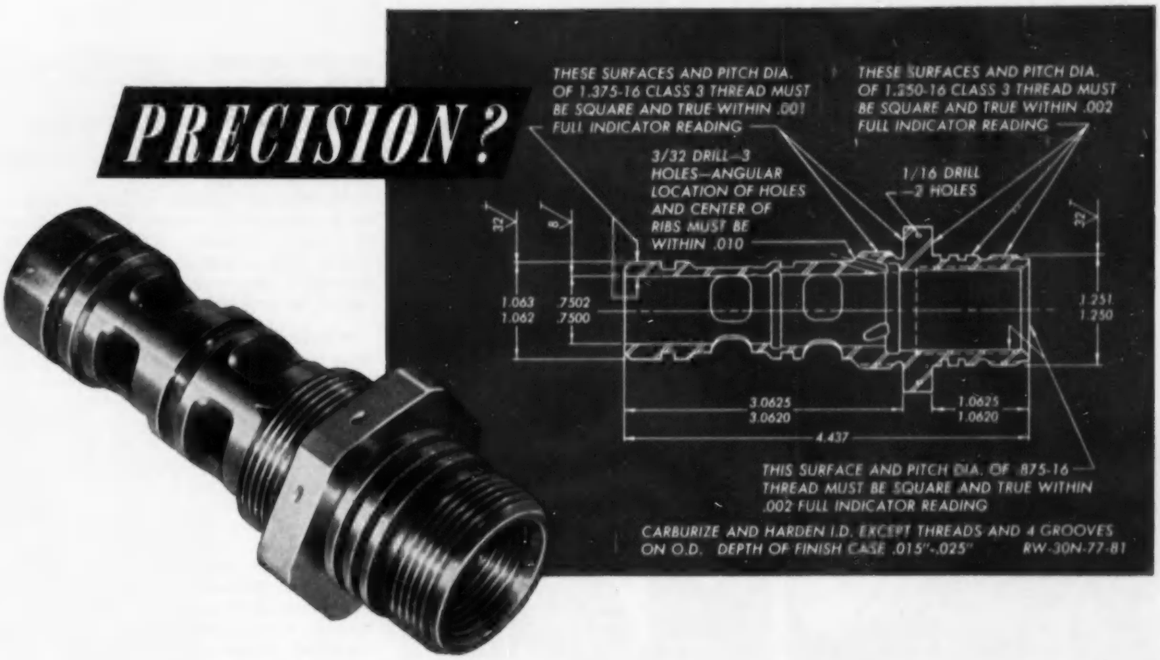
Based on paper by

DAVID BIERMANN

Hartzell Propeller, Inc.

SELECTING a propeller for a given utility airplane requires that various design compromises be faced. If a start is made by taking the ideal aerodynamic solution and resolving it step by step into several practical solutions, then comparing the performance of the compromise combinations reached, several conclusions can be drawn. These conclusions are:

- Maximum overall efficiency is obtained by a large slow-turning propeller of low activity factor, designed so that maximum efficiency occurs at the peak of the envelope efficiency curve, in the region of 35 deg blade angle. Such a propeller may be impracticable because of excessive weight and diameter.
- Reducing the diameter and in-



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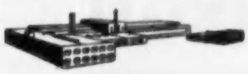
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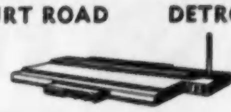
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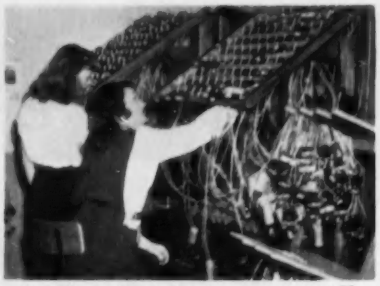

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creasing the rpm to practicable dimensions results in losses in efficiency throughout the flight range, depending upon how far this process is carried.

• This process eventually necessitates compensating for loss in diameter by increasing the solidity of the propeller, by increasing the blade width, number of blades, or both. However, solidity never fully compensates for a loss in diameter, although the overall design might be preferable for other reasons.

• Reducing tip speed to lessen noise may be accomplished either by reducing the rpm, or reducing the diameter and keeping the rpm constant. In either case, solidity must be increased to compensate for loss of tip speed. Reducing the rpm appears to be preferable from the efficiency standpoint, but reducing the diameter is probably more practicable in most cases.

Increasing the number of blades from two to three is desirable for reduction of propeller noise even though the tip speed remains constant. Three-bladed propellers are inherently smoother than the two-bladed type, hence desirable from the standpoint of comfort.

(Paper "Propeller Design for High Performance Utility Aircraft" was presented at SAE Wichita Section, Nov. 12, 1954. It is available in full in multilith form from SAE Special Publications Department. Price: 35¢ to members, 60¢ to nonmembers.)

Fabrication Affects Designing in Fiberglas

Based on paper by

L. LANDGRAF

Industrial Plastics Co.

DESIGNING a part to take full advantage of the unique properties of fiberglas requires paying close attention to its fabricating characteristics. Experience reveals that there are at least 10 points to keep in mind. They are:

1. If cost is important, remember that cloth costs from five to eight times as much as roving.

2. Fiberglas is impractical to machine because of its abrasive nature. Tools dull quickly, making impossible the holding of close tolerances. Machine shops equipped for close tolerance work are reluctant to handle jobs.

3. Tapped or reamed holes are impractical for the above reason. Drilled holes can be held to tolerances normal for holes drilled in dural, if drills are sharpened frequently.

4. Self-tapping screws are good for making attachments to fiberglas. Use

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the same size of drill recommended for sheet metal and have $2\frac{1}{2}$ threads or more engaging.

5. Soft aluminum rivets work best. When attaching fiberglas to metal try to have the driven head against the metal, otherwise a washer must be put under the driven head. Blind rivets of the pull-pin type do not work well.

6. The smoothest and fastest cutting can be done with a wet abrasive cut-off disk. This method is limited to straight cuts.

7. Fiberglas can be cut best with a $\frac{1}{4}$" diameter router, turning 20,000 rpm. The router bit should be solid carboloy with diamond shaped teeth.

8. It costs as much to bond two pieces of fiberglas as it does to make them. Six operations are required—remove parting agent, sand faying surfaces, mix adhesive, apply adhesive to both surfaces, place in bonding fixture and cure, then remove and clean up.

9. Ejector pins or other mechanically actuated loose pieces are impractical in molds for polyester resin. The mechanism is fouled quickly by the resin and becomes inoperative. Therefore, backdraft, undercuts and cross-coring, feasible with other types of molding, are impossible in polyester molding.

10. If part is to be press molded, do not specify local build-ups or varying wall thickness without providing a way to hold the extra glass needed in the thick area.

(Paper "Fabrication in Fiberglas" was presented at SAE Wichita Section, Nov. 13, 1954. It is available in full in multilith form from SAE Special Publications Department. Price: 35¢ to members, 60¢ to nonmembers.)

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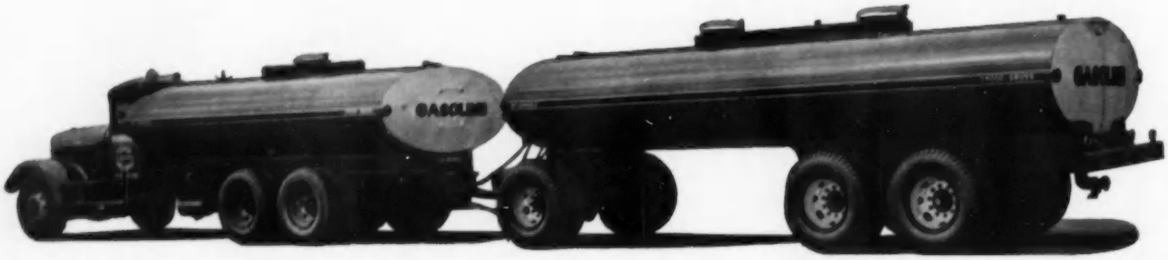

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responsible to high-level management, while in one instance it is permitted to call the shots, although the recommendations of engineering, planning, inspection, and production departments must be respected to facilitate smooth operation.

The methods of coordination to achieve change control vary among companies, but objectives are identical. There must be coordination with engineering, fabrication and assembly, inspection, procurement, planning, tooling, contracts, and spares departments, and finally the customer. This coordination has a direct bearing on the ultimate cost of change, regardless of method.

Air Force and Navy regulations governing classifications of changes are not identical in nomenclature, but the intent is much the same. The Air Force has "A" to "E" change classifications which are, respectively: safety of flight, military necessity, production, routine production, and miscellaneous. Matching these in substance are the Navy's classifications: safety of flight, combat effectiveness, improvement, and production facility.

Due to the urgency placed on change incorporation by the customer, so-called "crystal balling" has become standard procedure. It is no longer possible to wait for a firm engineering before establishing an effective point. Although it is desirable to have a package release of engineering to accomplish an ECP (engineering change proposal) or MCR (master change request), since "crystal balling" can be only as accurate as the word description of the change, the package release is almost a thing of the past.

(This article is based on the secretary's report of Panel on Change Control held as part of the Aircraft Production Forum at the SAE National Aeronautic Meeting, Los Angeles, Oct. 6, 1954. It is available in full in multilith form together with the reports of the other nine panels at this Production Forum, as SP-309 from SAE Special Publications Department. Price: $2.00 to members, $4.00 to nonmembers.)

Marines Like 'Copters For Moving Men, Cargo

Excerpts from paper by

COL. K. B. McCUTCHEON,

USMC, Marine Corps Equipment Board

MOVEMENT of troops and cargo is a job for the transport helicopter.

A squadron of Marine Corps HRS helicopters arrived in Korea in September 1951 and was still there as late as April 1955. Within two months after the squadron had arrived it had conducted troop lifts by night as well as by day. Such a capability really gives the ground commander a "Sunday punch." It introduces a third dimension into warfare in no uncertain terms. A great deal was learned in Korea but the one big drawback was the limited number of 'copters. At no time did the First Marine Division, under whose operational control this squadron was operating, have more than 15 of the HRS's.

The terrain in the sector assigned the division was rough. Although the hills were not particularly high, under 4000 ft, they were steep, rocky, and rugged. Natural landing sites were rare. Where they did not exist they had to be made. Sometimes the first men had to be lowered by means of knotted ropes in order that a site could be hacked out of the underbrush to permit subsequent 'copters to land. This of course precluded mass flights in formation. Instead the aircraft operated singly in file. This minimized the number of landing sites needed and also permitted the aircraft to fly low and in defilade to reduce the possibility of enemy observation.

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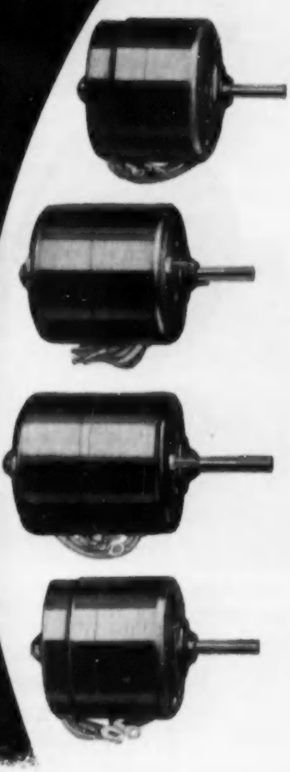

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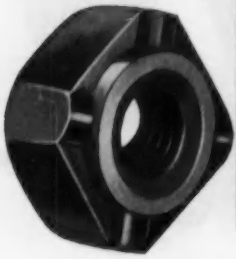

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A helicopter definitely is vulnerable. But so is any aircraft. So are boats, tanks, and men. This must be realized and tactics and techniques so worked out that the vulnerability is minimized.

In Korea, within the two Marine squadrons that operated helicopters, there were nine deaths, four of which were the direct result of enemy action. The other five were operational in nature. This was not a bad record considering the total number of flights made or of hours flown. It should not be used as a yardstick, however, for the future as the 'copters were never bothered by enemy air action and the percentage of the time that they were subject to ground fire was small.

One technique that was highly exploited was the so-called "flying crane" lift. Cargo was slung in a net underneath the aircraft and carried externally to the desired landing site. As soon as the load was deposited on the ground, the hook was released and the 'copter was off. This method was fast and efficient. Fuel of all types, ammunition, rations, and fortification materials of many varieties were carried in this fashion. It was also the only method available for transporting aircraft engines to downed helicopters and was resorted to on many occasions, often in very remote locations. Twice an entire HRS fuselage was flown out from a rocky peak back to the squadron's rear echelon. Carrying spare rotor blades was the trickiest problem, but this was eventually solved by constructing special racks along the sides of the fuselage. With this problem eliminated, the squadron could carry any part required to any downed 'copter.

Communications is a major problem for any commander. Although radio is used extensively, wire is still vitally important and it has some obvious advantages over the former, notably security. Laying wire by hand takes time and it is a tedious process. In terrain like Korea it could be nearly an impossibility. Here again is a natural for the helicopter.

A small 'copter like the HTL can be equipped with a special high-speed dispenser that is capable of paying out several miles of wire. Many special techniques have been developed for this kind of operation. One such is over-heading. Tracked vehicles and trucks of all kinds are the bane of a wireman. The 'copter can keep wire away from roads and thoroughfares by flying across country and placing the wire on the tops of trees. Trouble shooting such a line would of course be time consuming and boring business. In actual practice it is more expedient to lay a new line and salvage the old one.

For longer distances an HRS can be employed. The cabin space permits two men and several reels of wire to be accommodated so that longer lines can be emplaced. A hatch with a removable cover in the floor of the aircraft is readily adapted to paying out the wire. A certain amount of team-

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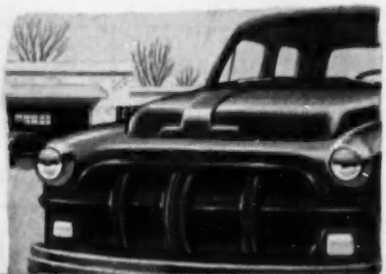

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work is required between the wiremen and pilot in order that extra reels may be spliced on if required. While this is being done the 'copter has to hover. (It is always embarrassing of course to lay a long wire only to find out you are a few yards short.)

Ground commanders learned very early in Korea that the helicopter is an ideal means of transportation. From battalions on up, commanders could readily utilize them. Only scarcity of numbers precluded them from being more widely used.

The 'copter gives the ground commander an aerial vantage point from which he can survey the terrain and disposition of troops personally. It permits him to visit subordinate and higher echelons with greater facility and by faster means than heretofore available. Just as the jeep replaced the horse, so is the helicopter replacing the jeep.

These are examples of the many, many tasks which the helicopter has performed in combat. It is in amphibious operations, however that the Marine Corps is primarily interested in applying these techniques. As mentioned earlier, the atomic tests, beginning with Bikini in 1946, stimulated activity in this connection. No longer could we afford to place a World War II-type amphibious task force at anchor a few thousand yards off the landing beaches. Such a disposition of shipping would be an ideal target for the enemy.

One answer seemed to lie in building into a task force greater speed, mobility, and dispersion. The helicopter is part of the answer. By substituting helicopters for water-borne landing craft, the task force can remain underway. Because the helicopter is 10 to 15 times as fast as landing craft, the task force can stay further to seaward, and it can disperse its units so that it will not present as tempting or profitable a target.

Other definite advantages accrue when using helicopters in lieu of boats. Conditions of wind, surf, and tide are not so critical. Underwater obstacles on the beaches and at the water's edge and beach mines can now be ignored. Furthermore, the selection of landing zones is no longer limited to the number of usable beaches in the objective area. Now the attacker can go over as well as around. Just as the forward pass changed the game of football, so will the helicopter change an amphibious operation.

This is not a subsequent step in the development of airborne operations. It is the application of new techniques to an amphibious operation. Parachutes and gliders have not been used in attacks launched from the sea although they have been used in airborne operations in conjunction with amphibious operations. The helicopter is superior. Less specialized training of troops is required, tactical integrity can be maintained in the landing and, what is more important, the capability is still retained of picking up the troops and moving them elsewhere as the situation requires.

Carriers can be ideal transports as the 'copters and troops can be embarked on the same ship. Cargo type ships can also be used if suitable landing platforms are built into the ship, although different techniques will have to be developed due to the limited 'copter handling capacity of such an arrangement.

Flights to the landing zone will be in formation and low to avoid radar detection. Overhead will be a cover of friendly fighter aircraft. In advance will be attack types working over the objective area with either atomic or non-atomic ordnance as required.

The 'copters will land, in formation if the terrain permits, discharge their cargo, and return to the task force for additional loads. With proper planning a maximum effort can be made initially, with a subsequent build-up of men, equipment, and supplies as fast as the time and space factors permit.

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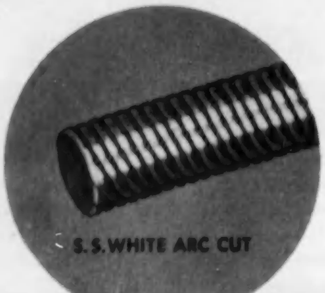

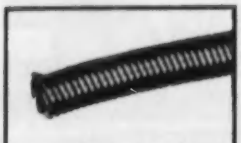
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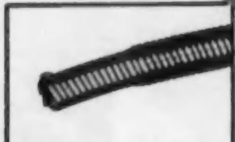
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"where the future is measured in light-years"

cannot be accomplished overnight. Many present equipments will have to be redesigned so that they can be carried by helicopter. Some will never be capable. In such a case their job will either have to be performed by other equipment, or a beach crossing appendage will have to remain as part of the operation.

Heavy tanks and engineer equipment, for example, will defy helicopter transportability for some time to come. Developments are coming along so rapidly, however, that they may not be required. To point out one specific possibility, heavy engineer equipment is required for construction of highways and airfields. With helicopters in sufficient numbers, road construction and maintenance requirements may be diminished. With application of the recently publicized vertical take-off principle in combat aircraft, extensive airfield preparations may be on the way out.

(Paper "Marine Corps Assault Aircraft Transports" was presented at the SAE Golden Anniversary Aeronautic Meeting, New York, April 20, 1955. It is available in full in multilith form from SAE Special Publications Department. Price: 35¢ to members, 60¢ to nonmembers.)

Revived Continental Retains Basic Design

Based on paper by

BEN D. MILLS

Ford Motor Co.

DESIGNING a modern version of the Ford Motor Co.'s Continental, which was discontinued in 1948, has proved a tough assignment for the stylists. After several abortive attempts, a process of evolution seemed to take hold of these stylists and they began working to recapture the better features of the original and to design a series of logical successors. Thus, models suitable for 1950, 1953, and finally, 1956, were developed.

Stylists have taken full advantage of the relationship of the lines of the design to make it seem longer, lower, and wider than it really is. Treatment of the rear tire mount, the most striking feature of the original Continental, remains a secret. It can be said that if there is a rear mount, it won't be like anything you buy in a kit or install yourself.

(Paper "The Continental—Past, Present, and Future" was presented at SAE New England Section, Jan. 4, 1955. It is available in full in multilith form from SAE Special Publications Department. Price: 35¢ to members, 60¢ to nonmembers.)

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These applicants qualified for admission to the Society between April 10, 1955 and May 10, 1955. Grades of membership are: (M) Member; (A) Associate; (J) Junior.

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From the smallest helicopter to the largest bomber MECHANICS Roller Bearing UNIVERSAL JOINTS *accuracy* has met every aircraft need. Designs, metals, machining, tolerances, heat treating, hardening balancing and lubrication — all have been specifically adapted for aircraft precision. Let MECHANICS universal joint engineers help solve *your* control and power transmission problems. Our new catalog, containing helpful universal joint engineering data and tracing kits, will be sent to engineers, upon request.

MECHANICS UNIVERSAL JOINT DIVISION
Borg-Warner • 2032 Harrison Ave., Rockford, Ill.

MECHANICS
Roller Bearing
BW
UNIVERSAL JOINTS

For Cars • Trucks • Tractors • Farm Implements • Road Machinery • Aircraft • Tanks • Busses and Industrial Equipment

New Members Qualified

continued

Twin City Section

Russell R. Gutteridge (M).

Washington Section

F. William Petring (M), William McKechnie Watson (A).

Wichita Section

Carl L. Rowe (A).

Williamsport Group

Floyd J. Bird (M), John B. Landis (A).

Outside Section Territory

R. G. Anderson (M), K. R. Babb (M), William D. Gallentine (M), P. E. Hardy (M), W. Cosby Hodges (A), G. William Moody (J), Charles Edward Morris (J), David S. Neuhart (M), Howard L. Pemberton (A), James A. Sharpsteen (M), Richard J. Strub (J), Hollis H. Travis (M).

Foreign

R. Chellappa (J), India; Rodney Eyre Clarke (M), England; Bernard James McCabe (A), Australia; John Ian Simcock (J), England.

Applications Received

The applications for membership received between April 10, 1955 and May 10, 1955 are listed below.

Alberta Group

James Tateishi.

Atlanta Section

Charles G. Habley, Harold Edwin Kite.

Baltimore Section

James W. Bohlander, George W. Westphal.

British Columbia Section

Jack Nelson.

Canadian Section

Fred C. Walter, Nicholas Gritzuk, Hector L. Humphrey, Harold F. Young.

Central Illinois Section

William P. Fuhst, Roy C. Heacock, Dale F. Johnson.

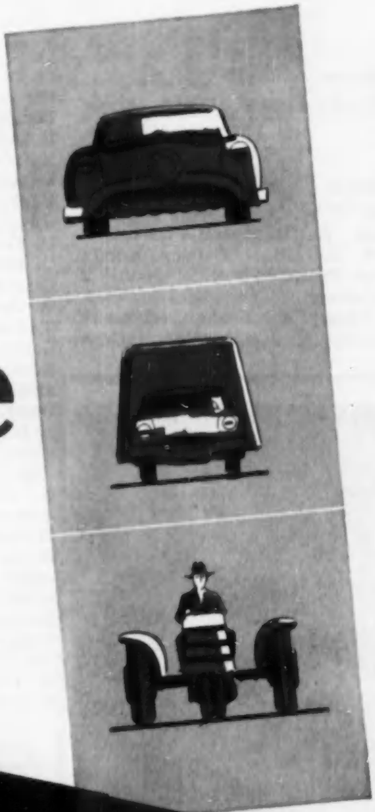
Chicago Section

Hayri Adanali, Stephen S. Baits, Wendell E. Eldred, Gerald H. Freier, Norman L. Ginder, Joseph J. Gray, Kenneth L. Hanson, Leo F. Hayer, Herbert C. Kroeplin, George V. Mercer, Frank E. Rollent, Albert H. Scherer, John L. Springer, Jr., Robert W. Supinger, Charles H. Sutton, George Taylor, George R. Willy, Herman M. Winkler.

Cincinnati Section

Robert L. Grunewald, Robert E. Larson.

first choice



for modern cars, trucks and tractors

"No Kick-Out" feature combines new starting efficiency with proven economy

• Higher compression ratios, lighter flywheels and other advancements in modern engines have long pointed up the need of a starter drive that would follow through the weak explosions until the engine actually runs on its own power.

That's why vehicle manufacturers are turning in ever increasing numbers to the Bendix* Folo-Thru Drive as the solution to quicker and more dependable starting even under most adverse conditions.

This preference for the Bendix Folo-Thru Drive on modern vehicles is a most logical one, for Bendix Drives have always been the industry's choice as the most economical and efficient starting equipment.

*REG. U. S. PAT. OFF.

ECLIPSE MACHINE DIVISION of

Bendix

AVIATION CORPORATION

ELMIRA, NEW YORK

Export Sales: Bendix International Division, 205 East 42nd St., New York 17, N. Y.

Bendix folo-thru starter drive

costs less. *Like the more than 95,000,000 Bendix* Starter Drives manufactured for the industry, the new Folo-Thru Drive requires no actuating linkage and the solenoid may be placed in any convenient position. Result is lower installation costs and no adjustments. Complete detailed information is available on request.*

Bendix* Folo-Thru Starter Drive  Bendix* Automotive Electric Fuel Pump  Stromberg* Carburetor 

Applications Received

continued

Cleveland Section

Mathew D. Baratko, Daniel P. Barnard, V. Donald V. Sarbach, Horace A. Shepard, Harry Ed Taber, Edwin C. Watson, Harold E. Wick, George A. Kling, Albert Saltsman, Jr.

Dayton Section

Robert P. Donley, Glenn Arnold Midkiff.

Detroit Section

George J. Adams, Robert J. Allen, Benjamin W. Badenoch, Calvin E. Bamford, Edward L. Barney, Donald W. Beane, Frank P. Biondo, George E. Bisbee, Samuel W. Blanton, Stefan P. Boran, Shane H. Brady, Nelson R. Brown, John T. Buckmaster, Jack A. Bush, Maurice B. Calfin, Alfred L. Carter, Albert S. Colinas, James T. Congelliere, Richard R. Crandall, Ralph Emerson Cross, D. J. Davis, Donald G. Davis, John D. Dietiker, Leonard A. Dreisbach, Harold R. Fisher, Burr J. French, Harold H. Gasser, Edwin S. Getner, Robert O. Gibson, Don D. Goodsell, John D. Gowie, Douglas C. Hewitt, Frank R. Holliday, Jordan E. Johnson, Donald A. Jones, Milton W. Jumisco, Alfred W. Klomp, Stephen T. Kusner, Yun-Ting Kwan, Robert J. Lauer, George W. Lawler, Louis M. Lutz, Edgar M. MacDonald, Alex D. MacMillan, Jr., Gordon A. Meyers, Donald D. Miller, Thomas G. Montgomery, Rexford Moulton, Gilbert D. Pierron, B. F. Poffenberger, Nick Popiel, Jr., William E. Reinsel, James S. Rodgers, Henry J. Roesch, Jr., Joseph A. Sember, Paul Shiloff, Leo Edward Siess, Carl Smereck, George E. Spaulding, Jr., Frank S. Staron, Jerzy Sztykiel, Robert I. Thomas, Wilfrid G. Torrance, Richard E. Truesdell, Robert H. Vorech, Clifford Charles Voss, Darwin A. Wasmer, Wallace R Welch, William E. Widmaier, Robert W. Wolverton, Louis J. Zimmel, Edward G. Zwiller.

Indiana Section

Harry W. Grinstead, Robert B. Kurre, John Howard Letsinger, A. Merril Morris, Jane Sundling, Thomas J. Weir.

Kansas City Section

R. B. Speirs, Gale M. Baker, Floyd H. Norriss, George P. Townsend, Jr.

Metropolitan Section

A. Joseph Aldi, Irving T. Bartlett, Jr., Frank Cozzarelli, Edward J. Dixon, Victor Emanuel, Ralph Gladstein, Peter J. Hart, Richard M. Hofmann, Robert B. Kaplan, Theodore Malgeri, William S. Mounce, Fred Elmer Nelson, Mundy I. Peale, Theodore S. Starr.

Mid-Continent Section

C. Converse Grimshaw, Monte Lee Kendrick, Ted W. Legatski, Edwin A. Neugass, William Bruce Pate, Edward H. Toomey, Paul D. Williams.

Mid-Michigan Section

Clayton W. McPhee, Lester E. Patterson, Eldridge W. Reese, James R. Reif, F. Eugene Smythe, Robert E. Walker.

Milwaukee Section

Jay Clark, II, Richard Luedtke, John N. Moore, Jack L. Morgan, L. H. Nordstrom, W. Eugene Sinner, E. C. Stiedemann, Edwin C. Vollrath, Walter H. Zirzow.

SERVICE RINGS

For over thirty years the name Wausau has stood for quality piston rings. Wausau has worked closely with engine manufacturers in the development and design of service piston rings to meet their rigid specifications. Wausau goes a step further—by also assisting the engine builder in the creation of attractive, compact service piston ring set packaging. It is this experience and association that has made Wausau a leading producer of service piston rings.

We will gladly have one of our representatives give you the details. Call or write us.

Wausau Motor Parts Company
2200 Harrison Street, Wausau, Wisconsin

Applications Received

continued

Mohawk-Hudson Section

Kenneth E. Luther, Jr.

Montreal Section

Andre Melikoff, John N. Pryce, Maurice J. Stevenson.

New England Section

Edward E. Burritt, Jr.

Northern California Section

Haig Asdurian, Edward R. Howard, Charles H. Johnson, Vincent Villasenor.

Northwest Section

L. O. Kittelson, Harold C. Varney.

Philadelphia Section

E. N. Alexander, Charles M. Clapper, A. J. Holt, Robert A. Tross.

Pittsburgh Section

Edgar L. Fix, Harold G. Hall.

San Diego Section

Richard A. Binienda, Louie A. Cappello, Andrew J. Edwards, Ronald L. Farrar, David Krause, Stanley G. Thomas.

Southern California Section

Anselmo A. A. da Rocha Barros, Mitchell B. Haisten, Stanley F. Parkill, Joseph Henry Shirar, Tatsuo W. Tsukahira, George F. Wienwurm, Robert W. Young.

Southern New England Section

H. Mansfield Horner, William R. Johnson, James K. Patrie, Eugene D. Rochette, Hamilton Smith, Jr.

Texas Gulf Coast Section

John W. Kelly, Jr., Dane E. Smith.

Texas Section

Allen W. Cain, Jr., Charles G. Martin, Jr., John McMahon, George Sadek.

Twin City Section

Neil F. Brown, Allan G. Cederberg.

Washington Section

Swaminathan Kunjithapadam.

Outside of Section Territory

Harry J. Charette, Henry W. Cutchin, Jr., Ernest D. Garrett, William S. Gray, Jr., Francis H. Griswold, Wilbert G. Kautz, Joseph H. Pereue, Alvin E. Shugarman.

Foreign

Rolf Goetze, Germany; Christian N. Kristoff, Australia; R. N. Misra, India; Gopalsami Dorasami Naidu, India; Heinrich Nordhoff, Germany; Leonard A. Paterson, England; Exalt Pinto, Pakistan; Noel J. Reilly, Jordan; Giovanni Savonuzzi, Italy; John E. Shepherd, England; Torsten R. Verkkola, Finland.

ALLOY #2 VALVE SEATS

"Sit Tight" In Aluminum Alloy Engines!

Wausau offers you the solution to valve seat problems in aluminum blocks and heads. Alloy #2 valve seat inserts are engineered specifically for aluminum block and head applications . . . are based on years of experience and development.

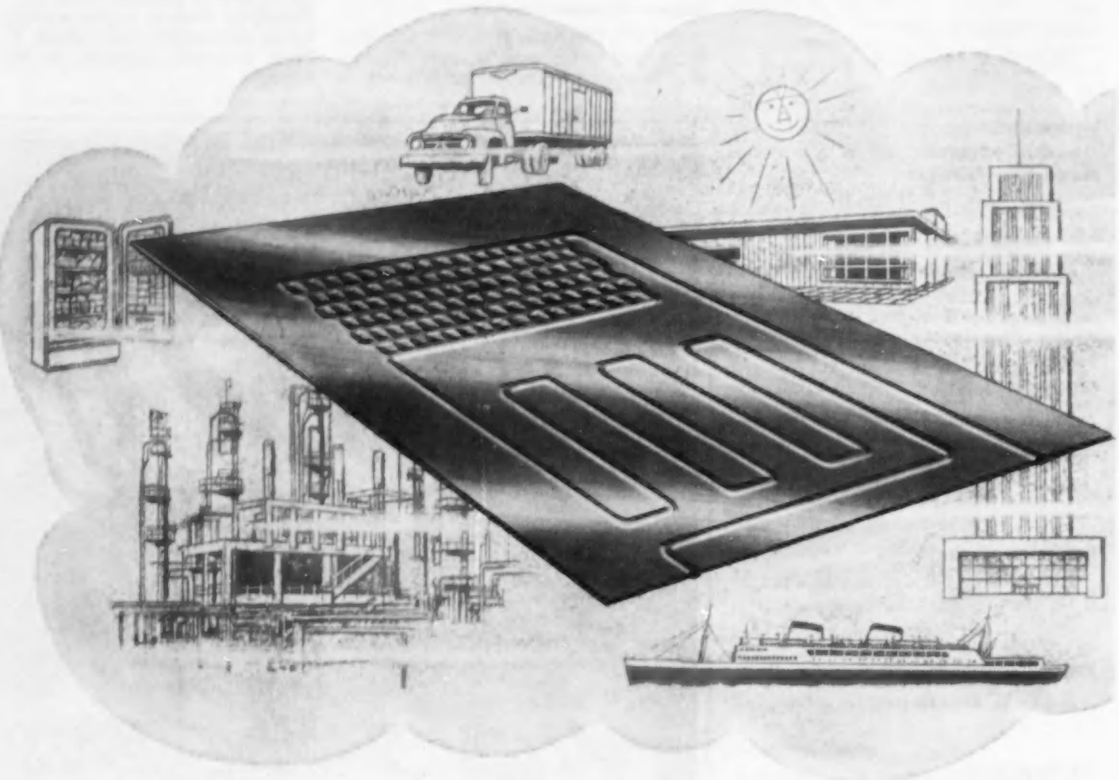
Valve seat inserts made of Wausau #2 Alloy have the *same coefficient of expansion* as many of the popular aluminum alloys, they just don't work loose! They resist corrosion and wear . . . actually work-harden with use. Long life is further assured by high impact resistance. Extreme stability under heat resists distorting or burning even under the most severe conditions. Using this alloy, Wausau engineers can design valve seat inserts for lightweight engines of all sizes.

Alloy #2 is only one of many which Wausau has developed to solve specific insert application problems. Write for complete details on this and other Wausau metallurgical advances in valve seat inserts, and piston and sealing rings.

Wausau Motor Parts Company
2200 Harrison Street
Wausau, Wisconsin

Go ahead and dream! Here's the exciting new material to complement your design and engineering skill!

REYNOLDS ALUMINUM



What Tubed Sheet Is: *Tubed Sheet* is actually two sheets of aluminum metallurgically bonded together so that the heat transfer passageways are *in the sheet.* These expanded passageways route gas or liquid wherever needed with greater freedom, greater efficiency and at lower cost.

Where this new concept in heat transfer applies in transportation, chemical and petroleum, construction and many other industries:

Imagine the possibilities that *Tubed Sheet* offers in *automobile* radiators and air conditioning systems—perhaps even in future radiant heating systems for cars! Or consider *trucks* and *trailers* with refrigerating panels inside roof, sides or floor to surround cargos with constant temperatures! Take *aircraft*, too. De-icing applications in skin of planes; cockpit cooling systems; guided missiles! *Chemical, petroleum* and *petrochemical* industries can benefit from *Tubed Sheet* in air coolers and other heat transfer applications. Radiant heating panel and solar heating systems can bring the advantages of *Tubed Sheet* to the *building* and *construction* industry.

See Reynolds new network television show..."Do-It-Yourself"...Sunday evening on NBC-TV.

REYNOLDS ALUMINUM

BLANKING • EMBOSSING • STAMPING • DRAWING • RIVETING • FORMING

TUBED SHEET

Now Being Produced by Reynolds Patented Roll Bonded Process

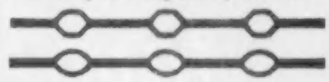
And consider this. Already design and engineering men are planning uses for this amazing new material in appliances *other than* heat transfer alone! So go ahead and dream. Reynolds *Tubed Sheet* is the exciting new material that can give *your ingenuity* a chance to really operate!

How Performance and Economy Benefits Have Been Proved:

Refrigerator evaporators now being produced by Reynolds for the appliance industry point up the advantages of *Tubed Sheet.* Here are some already proved benefits:

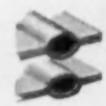
Greater freedom in tubing pattern designs

Greater efficiency because there is no loss in conductivity as tubing is integral to sheet



Greater economy through savings in manufacturing operations and in metal

Greater strength because there are no tubes to pull away from sheet—passageways can be flat or oval and placed closer together for extra rigidity



Reynolds *Tubed Sheet* is available with smooth surface or embossed pattern. Where desired, Reynolds *Tubed Sheet* parts can be furnished color anodized in a variety of eye-appealing colors.

Get full details on Reynolds *Tubed Sheet* now. Contact the Reynolds office listed under "Aluminum" in your classified telephone directory or . . .

Write

REYNOLDS ALUMINUM FABRICATING SERVICE
2086 South Ninth Street
Louisville 1, Kentucky

FABRICATING SERVICE

ROLL SHAPING • TUBE BENDING • WELDING • BRAZING • FINISHING

Of importance to the entire aircraft industry is this announcement that Marman Products Company, Inc., Los Angeles, is now a wholly owned subsidiary of Aeroquip Corporation, Jackson, Michigan.

Both companies are well known throughout the aircraft industry. Both are recognized as leaders with outstanding records in the design, development, and installation engineering of aircraft components. Even the products have much in common. In many installations, Marman band clamps, V-band couplings, channel band couplings, stainless steel straps, flexible fuel line couplings and the new lightweight LIVE joint system go hand in hand with Aeroquip flexible hose lines and self-sealing couplings.

As a subsidiary of Aeroquip, Marman is in excellent position to expand its sales, service and engineering facilities. Please write for further information.

MARMAN PRODUCTS COMPANY, INC.

A SUBSIDIARY OF Aeroquip CORPORATION

11214 EXPOSITION BLVD., LOS ANGELES, CALIFORNIA

MARMAN PRODUCTS ARE MANUFACTURED UNDER VARIOUS U.S. AND FOREIGN PATENTS AND OTHER PATENTS PENDING

Judge a Product by its Users

The new Martin XP6M Seamaster, world's first multi-jet attack seaplane, proves that water-based planes can be fast, maneuverable . . . and BIG. Contributing to the Seamaster's remarkable performance are Aeroquip 601 lightweight engine hose, 617 lightweight air frame hose, and high temperature, 3000 p.s.i. self-sealing couplings.

Aeroquip

REG. TRADEMARK

Aeroquip Corporation, Jackson, Michigan • Aero-Coupling Corporation, Burbank, California (*A subsidiary of Aeroquip Corporation*)

Local Representatives in Principal Cities in U.S.A. and Abroad. Aeroquip Products are fully Protected by Patents in U.S.A. and Abroad.

Here's the secret of Micronic*-type Purolator's HIGH FLOW RATE

This little Purolator filter element can clean a quart of dirty lube oil in 60 seconds. It takes out sludge and solid impurities as small as one micron (.000039-inch) yet leaves beneficial additives unaffected. It operates with minimum pressure drop and a standard-size oil pump.

You can see the secret at the left. It's the Purolator Micronic element. This accordion-pleated, resin-impregnated element provides ten times the filtering area of older elements. This means faster filtration rates and far greater dirt storage capacity.

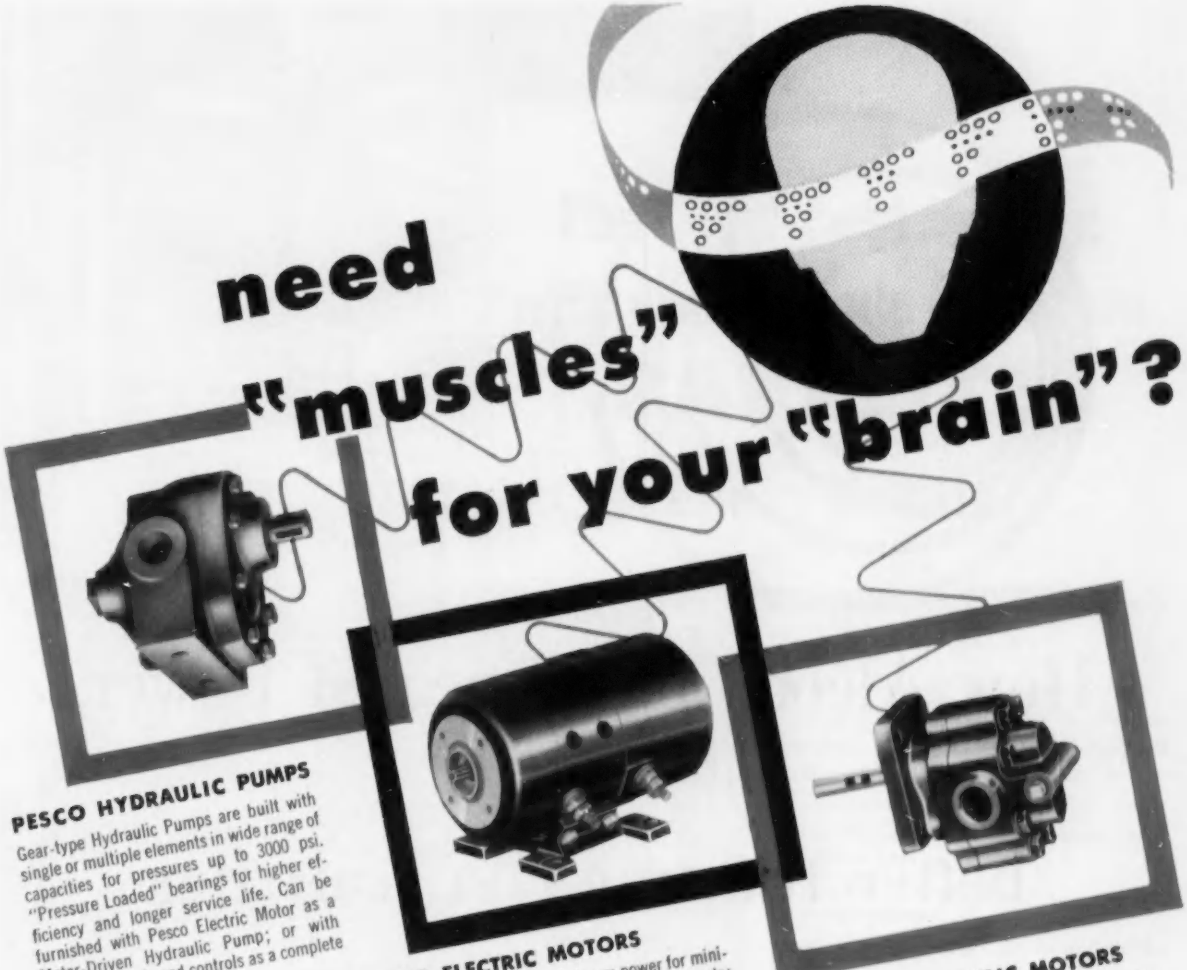
To designers and users of automotive equipment, Micronic-type Purolators offer thorough filtration by a small, compact unit that fits snugly into the lubricating system without needing an oversized pump to boost pressures through the filter. These advantages of Micronic filtration are among the many reasons why original automotive equipment manufacturers use more Purolators than any other type of filter.

Micronic elements do not channel. They are waterproof and warp-proof and remain unaffected by engine temperatures. There's a Purolator to fit every vehicle, tractor, and other gasoline- or diesel-engine-powered unit in service today. Write for our automotive catalog, No. 2054, to Purolator Products, Inc., Rahway, N. J., Dept. A3-617.

*Registered Trade Mark

PUROLATOR

"FIRST IN THE FIELD OF FILTERING"



PESCO HYDRAULIC PUMPS

Gear-type Hydraulic Pumps are built with single or multiple elements in wide range of capacities for pressures up to 3000 psi. "Pressure Loaded" bearings for higher efficiency and longer service life. Can be furnished with Pesco Electric Motor as a Motor-Driven Hydraulic Pump; or with motor, reservoir and controls as a complete Pesco Power Package.

PESCO ELECTRIC MOTORS

Precision-built Pesco motors provide maximum power for minimum size and weight. Many types available for special needs; models with rigidly exact performance for servo applications.

Both DC and high frequency AC motors built in 5 coordinated frame sizes from 1/100 to 11 hp permitting use of standard parts to expedite design. Many superior features to meet any requirement on humidity, temperature, vibration, duty cycle or altitude.

PESCO HYDRAULIC MOTORS

Gear-type, positive displacement fluid motors to provide highly efficient, rotary, variable speed hydraulic power. Lightweight and compact, motors operate in either direction without mechanical adjustment. Starting torque efficiency is over 90%. Models available for operation at pressures to 1500 psi.

Does your electronic "brain" require hydraulic or electrical "muscles"?

To assure precise functioning of automatic devices, servo mechanisms, control equipment and instruments, equip them with *power by Pesco*—Hydraulic Pumps, Hydraulic Motors and Electric Motors. These aircraft-quality units operate with unmatched precision and absolute dependability over a long service life. They are extremely compact, lightweight and ruggedly built for severe environmental conditions.

For information on how these Pesco products can be applied to your particular problem, contact: PESCO, 24700 North Miles Rd., Bedford, Ohio.

engineering
Pesco
PRODUCTS DIVISION
production

BORG-WARNER CORPORATION
24700 NORTH MILES ROAD • BEDFORD, OHIO

How Alcoa helped Sealed Power develop a better transmission seal ring

As aluminum came into use in automatic transmissions, it became apparent that there was a need for transmission seal rings with a different coefficient of expansion than that exhibited by cast iron.

Engineers at Sealed Power Corporation turned to Alcoa—and aluminum—for help in developing a better ring for use in aluminum bores. First, it had to have the proper coefficient of expansion. For if the ring does not expand as rapidly as the body, the gap opens and oil pressure drops. If the ring expands too rapidly, the gap will butt, resulting in mechanical failure. In addition, the ring had to have good wearing qualities and the necessary physical properties to produce a good piston seal ring.

Altogether something over two years was spent in a co-operative effort to select the proper alloy, the best Alumilite* finish and the most economical method of production. Alcoa's Development Division in Cleveland built temporary equipment to produce castings in sand, in plaster, in semipermanent mold and full permanent mold, and investigated the possibility of centrifugally casting ring sleeves.

*Trade Name of Aluminum Company of America

Sealed Power aluminum transmission seal rings are now in use in one automatic transmission, have been approved as a 1956 production item in another and are on test in other transmissions.

* * *

If you believe aluminum offers possibilities for improvement of your product, call in an Alcoa sales engineer. Have him put the unequaled facilities of our Development Division to work on your problem. Aluminum Company of America, 1844-F Alcoa Building, Mellon Square, Pittsburgh 19, Pa.

YOUR GUIDE TO ALUMINUM VALUE

ALCOA ALUMINUM

ALUMINUM COMPANY OF AMERICA

©ALCOA

Fasten Aluminum With Alcoa® Aluminum Fasteners

Fast, low-cost tooling with compounds based on BAKELITE Epoxy Resins

TRADE-MARK

Ren-ite® Plastic tooling compounds cut costs on this job by four fifths! Delivery time was cut 70 per cent! Drop hammer dies for this press are made of compounds based on Bakelite Epoxy Resins and produced by **Ren-ite Plastics**, Lansing 4, Mich. The dies stamp these trays out of 75 SO aluminum sheet.

Frequent model changes and tough competition demand quick tooling at less cost. Look into these advantages of Bakelite Brand Epoxy Resins for metalworking tools:

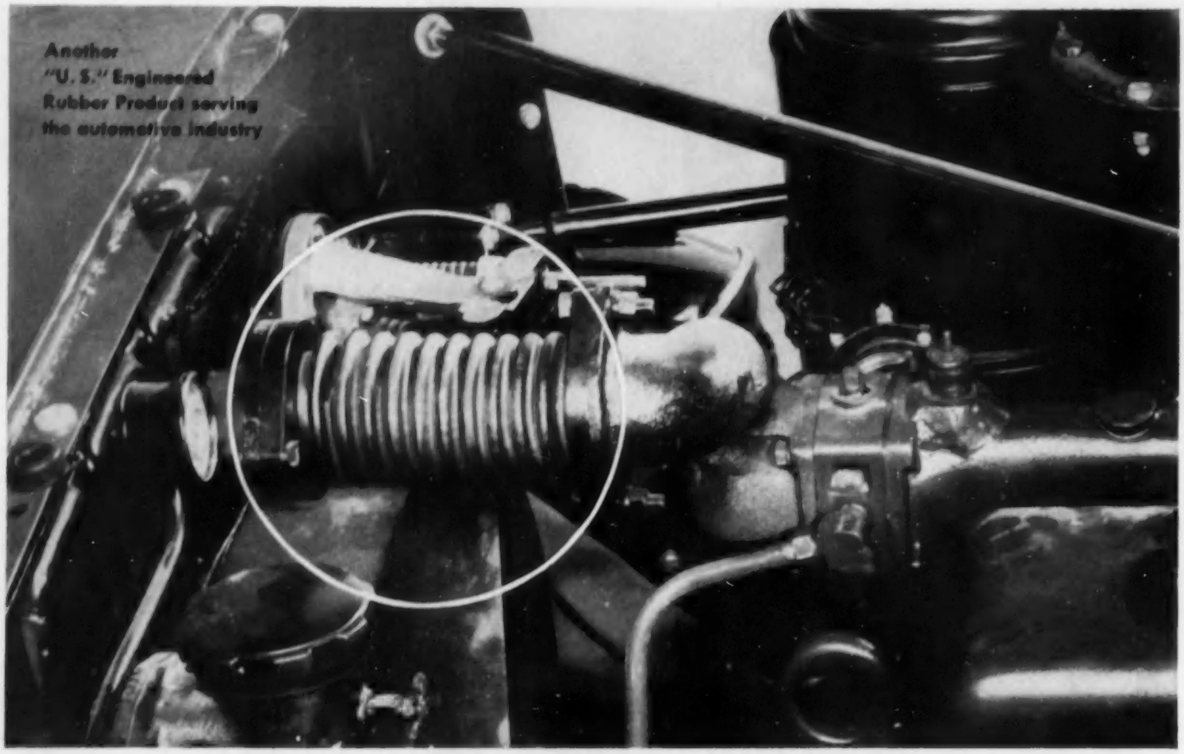
- **Liquid compounds—can be cast to shape without pressure**
- **Cured at room temperature—no applied heat**
- **Minimum shrinkage—minimum finishing**
- **Excellent flexural, compression, and impact strengths**
- **Outstanding dimensional stability**
- **Light weight means easy handling**
- **Laminated with glass cloth to form jigs, spotting racks, fixtures, and Keller models.**

BAKELITE
BRAND
EPOXY RESINS

BAKELITE COMPANY, *A Division of Union Carbide and Carbon Corporation* UCC 30 East 42nd Street, New York 17, N. Y.

In Canada: Bakelite Company, Division of Union Carbide Canada Limited, Belleville, Ontario

The term Bakelite and the Trefoil Symbol are registered trade-marks of UCC



Have YOUR hose and connections the "GIVE" it takes?

U. S. MULTI-FLEX "gives" movement in extension and compression—indefinitely!

Multi-Flex® has proved its superiority for a wide number of applications, including radiators, carburetor air intakes, boots for hydraulic pistons, shock absorbers, worm gears and sensitive adjusting screws, exhaust outlets for garages, and hundreds more.

For example, as a connection between the cast tubular line from the radiator and the engine tubular line, U. S. Multi-Flex provides *flexibility,* allows the engine to move without transmitting force, both laterally and fore and aft on the radiator. Unlike Multi-Flex, a rigid piece of hose would exert a high degree of leverage force on the radiator and the radiator tank. Multi-Flex is available with flanges at either end; it also can be fastened in the conventional manner with clamps.

Since it's made without molds, special mandrels, or supporting wires, natural or synthetic rubber Multi-Flex can be fabric-reinforced, too—produced in inside diameters all the way from ⅛" to 36", in lengths unlimited. And one special Multi-Flex formulation withstands temperatures from –65°F to 500°F! Unlike wire supported hose, it can be crushed repeatedly without harm.

The extensibility of Multi-Flex makes short lengths practical; its ease of application (with slip-over nipple or flange connectors) saves assembly line time. For *"all-ways"* flexibility—for the greatest travel with the least fatigue—for *economy* and *long life,* you'll find you just can't match Multi-Flex.

Most samples for experimental use can be made without tooling charges. For samples and engineering service, phone us in Detroit at Trinity 4-3500. It's your contact with *specialists* in automotive rubber applications.

"U. S." Research perfects it... "U. S." Production builds it.

US RUBBER

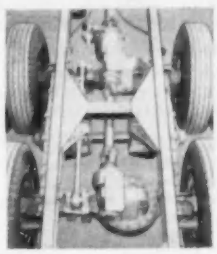
UNITED STATES RUBBER COMPANY

Automotive Sales, Mechanical Goods Division · New Center Bldg., Detroit 2, Michigan

the fleet's in...

BUT NOT FOR LONG!

White trucks keep rolling for profits—with long-lived BLOOD BROTHERS propeller shafts



Rugged, reliable White trucks are famous for their ability to pile up long miles of profitable road time . . . on *very* little shop time!

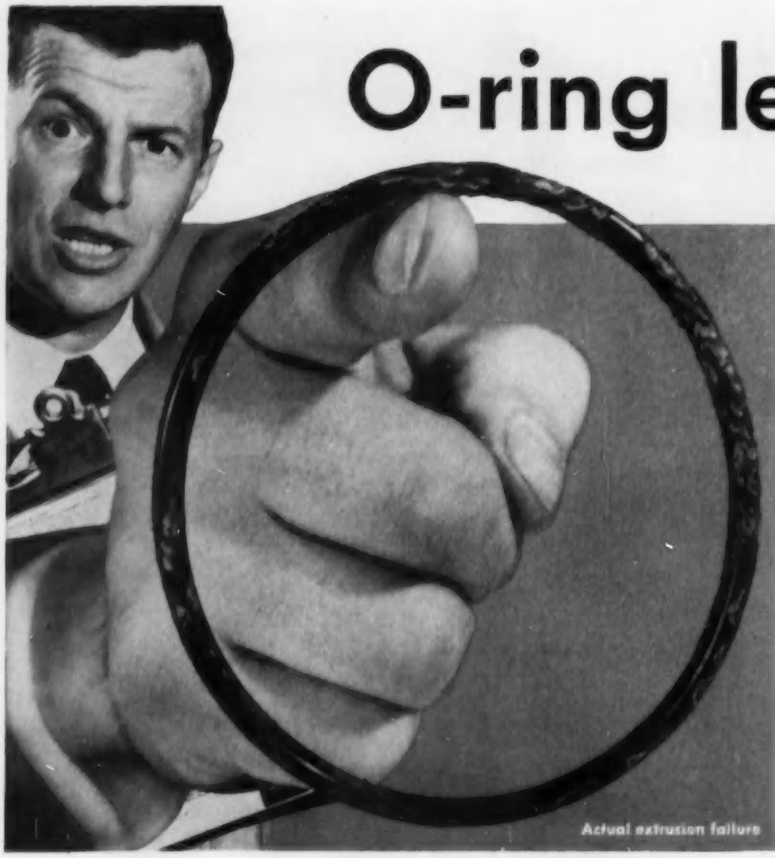
Contributing to this record of low ton-mile cost are the rugged Blood Brothers Propeller Shafts. Precision-balanced for high speed trucks and buses, they're top-quality components that can help keep *any* fleet earning!

Blood Brothers' engineers will gladly discuss *your* universal joint and propeller shaft problems. Just write or call . . . no obligation.

BLOOD BROTHERS
MACHINE DIVISION
ROCKWELL SPRING AND AXLE COMPANY
ALLEGAN, MICHIGAN

UNIVERSAL JOINTS AND DRIVE LINE ASSEMBLIES

O-ring leaks?



. . . then call in your Parker field engineer for help

Having trouble with O-ring failures? Nibbled, worn, battered, leaking like a sieve? Whether your problem is in the basic design or compound, it's time to call a Parker representative.

Parker field engineers are trained trouble shooters. There is one in your area. From Parker you can get exactly the *right* O-ring and gland design for your *specific* application.

Compare Parker O-rings with any other make. You'll find that Parker O-rings are precision-molded of superior compounds. They have been developed as the result of years of experimentation to provide the proper elongation, tensile strength, compression set ratings, resistance to oils, fuels, chemicals, and high and low temperatures. Laboratory and service tests make sure that all rated characteristics are held.

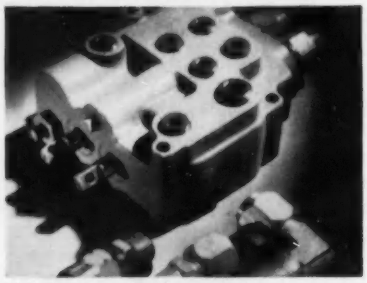
Call your Parker representative for assistance. Mail the coupon for *free* technical bulletins about O-rings.

RUBBER PRODUCTS DIVISION
The Parker Appliance Company
17325 Euclid Ave., Cleveland 12, Ohio
1538 So. Eastern Ave., Los Angeles, Cal.

Parker
Hydraulic and fluid system components

Heat failure was caused by a combination of compound and design problems. Parker field engineer was called. Leaks were stopped . . . and complaints ended.

Compare actual samples. Ask your Parker representative to check your specifications and design. Let him prove how Parker O-rings seal better, last longer.



What other Parker products interest you? *Triple-lok* flare tube fittings? Ferulok flareless fittings? *Hoze-lok* fittings? Hydraulic directional control valves?

RUBBER PRODUCTS DIV.
Section 513-M
The Parker Appliance Co.
17325 Euclid Ave.
Cleveland 12, Ohio

Please send the following bulletins:
- ☐ Silicone Rubber Bul. 5605 B1
- ☐ Materials for O-rings Bul. 5705 B1
- ☐ O-ring Operation Factors Bul. 5705 B2
- ☐ Thermal Properties Bul. 5705 B4
- ☐ Rotary Seal for High Speed Bul. 5705 B5
- ☐ Aircraft Hydraulic Packings Bul. 5712 B1

Name ____________
Company ____________
Address ____________
City ____________ State ____________

DuPont Research Report

Additives recently developed to meet changing fuel and lubricant needs

Du Pont Petroleum Laboratory reports rapid progress in development of additives to improve performance of automotive fuels and lubricants.

Stop-and-go city driving amid creeping traffic congestion, high-speed turnpike driving, and the growing use of diesel power are important factors in our rapidly changing automotive industry. As they develop and progress, new problems involving automotive fuels and lubricants are encountered.

To help you solve these problems, the Du Pont Petroleum Laboratory is constantly at work on the development of new chemical additives for fuels and lubricants. Here is what you will want to know about three of the recently-developed additives which are now in commercial production.

New Du Pont Lube Oil Additives 564 and 565

Now, for the first time, an effective detergent can be added to overcome sludge problems caused by low-duty, stop-and-go engine operation. And the same additive is also a viscosity-index improver.

What's more, there is a choice of two different additives for this purpose—Du Pont Lube Oil Additives 564 and 565. Both are new-type, ashless, polymeric additives with outstanding detergency and varying in shear stability and viscosity-index improving properties. Of the two, the lower molecular weight of LOA-564 provides good shear stability while LOA-565, with a higher molecular weight, is ideally suited for motor oils where high viscosity improvement at low cost is a major objective.

How effective are they?

To evaluate the efficiency of LOA-564, a representative number of taxicabs were tested, starting with new engines, in 50,000 miles of low-duty service (with oil-drain periods at 4500 to 5000 miles). Typical results are indicated in the photographs below.

NOTICE THE DIFFERENCE in sludge on the oil screen and timing gear cover on the left as compared with the clean appearance of the corresponding parts on the right. Those on the left were operated on a representative heavy-duty, 10W-30 motor oil (for service MS and DG). The cleanliness of those on the right resulted from the use of the same base oil to which Du Pont Lube Oil Additive 564 plus an antioxidant and additional V.I. improver had been added.

FOA-2 for diesel fuels

Although it has been in commercial production only a relatively short time, Du Pont Fuel Oil Additive No. 2 has already proved its effectiveness as a stabilizer and dispersant for diesel fuels, as well as for heating oils.

Because of its excellent dispersant action, FOA-2 improves the filterability of diesel fuels. In this way, it helps to eliminate most injector-sticking and filter-plugging problems. It's extremely economical to use, too, because it is effective in low concentrations.

For more detailed information about any of these additives, address your request to any of our regional offices listed below.

DU PONT
REG. U.S. PAT. OFF.
Better Things for Better Living . . . through Chemistry

Petroleum Chemicals

E. I. DU PONT DE NEMOURS & COMPANY (INC.)
Petroleum Chemicals Division • Wilmington 98, Delaware

Regional Offices:
NEW YORK, N. Y.—1270 Ave. of the Americas . . . Phone COlumbus 5-2342
CHICAGO, ILL.—8 So. Michigan Ave. . . . . Phone RAndolph 6-8630
TULSA, OKLA.—P. O. Box 730 . . . . Phone Tulsa 5-5578
HOUSTON, TEXAS—705 Bank of Commerce Bldg. . . . Phone BLackstone 1151
LOS ANGELES, CALIF.—612 So. Flower St. . . . . Phone MAdison 5-1691

IN CANADA: Du Pont Company of Canada Limited—Petroleum Chemicals Division, 80 Richmond St. W., Toronto 1, Ont.
OTHER COUNTRIES: Petroleum Chemicals Export—Nemours Building, 6539—Wilmington 98, Delaware

Designed to meet your own specifications...

These J-M Friction Materials combine high performance with economy

● Johns-Manville Asbestos Friction Materials are made *right* to give the high performance required by your own exacting specifications. Backed by a half century of experience and research, the development of the *complete line* of Johns-Manville brake linings and clutch facings has gone hand in hand with the advancements and refinements of the automobile itself.

Whatever the vehicle—or its friction material requirements—a Johns-Manville Friction Material will meet the need. In addition, the J-M engineering staff and best equipped research laboratory for friction materials are at your service. Your Johns-Manville Representative can tell you about this service . . . or write for information to Automotive Division Manager, 22 East 40th Street, New York 16, N. Y.

JM Johns-Manville *asbestos* FRICTION MATERIALS

80 million
is a lot of
Sealed Power
SEALING RINGS

That's well over half of all the sealing rings that have ever been made—because Sealed Power is far and away the largest manufacturer of rings for automatic transmission and power steering.

It all began away back before World War II, when tanks needed sealing rings. Sealed Power, with its long experience and fine engineering staff and laboratory facilities, was the natural source of supply. That was seventeen years ago.

Now Sealed Power makes sealing rings for passenger cars, trucks, buses—and, of course, for tanks. Sixteen of the nineteen makes of cars now using automatic transmissions use Sealed Power sealing rings.

Sealed Power is best qualified to help you solve your own sealing ring problem. Your inquiry will receive prompt attention.

Sealed Power Corporation

MUSKEGON, MICHIGAN

Sealed Power Chrome Piston Rings are used by 28 leading engine builders!

Crash Program

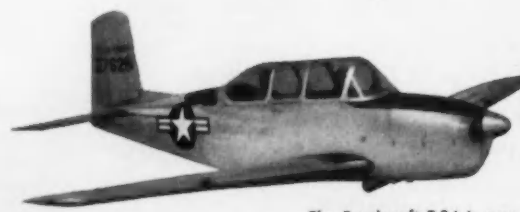
All Beechcrafts are built to Beechcraft's own standards of Safety. These standards are higher than those required by the U. S. Government.

This long-established Beechcraft policy produces airplanes with the "Plus Factor" that means extra safety for their occupants, long life, and freedom from expensive repair bills.

In the case of the Beechcraft T-34B basic trainer for the U. S. Navy, the specifications required a high degree of landing gear ruggedness, to be proved by repeatedly dropping the airplane onto its wheels from a considerable height, at full gross weight.

Progressively more severe drops were made until the Navy requirement was met, and passed. Higher drops of the airplane continued without significant damage. The above photograph shows *the 186th drop test* which successfully imposed loads *74% greater* than the Navy specification, *and without significant failure.* This is another demonstration of the *"Plus Factor"* possessed by Beechcrafts and rendered to their owners, as better service and decreased cost of upkeep.

TO ENGINEERS who are skilled in aerodynamics . . . or structural design . . . or flutter and dynamics . . . or electronics . . . or physics . . . or missiles control . . . or weapons systems, BEECHCRAFT may offer an opportunity that is superior to the average job opening. BEECHCRAFT is aggressively entering new fields and needs skilled engineers to do creative work of top-level quality in these fields. If you would like to be associated with a leading organization that is large enough to have diversification of product, but small enough to insure recognition of personal ability shown by those who have it, and if you do possess superior skills in the categories mentioned, write today to Beech Aircraft Corp., Employment Div., Wichita, Kans.

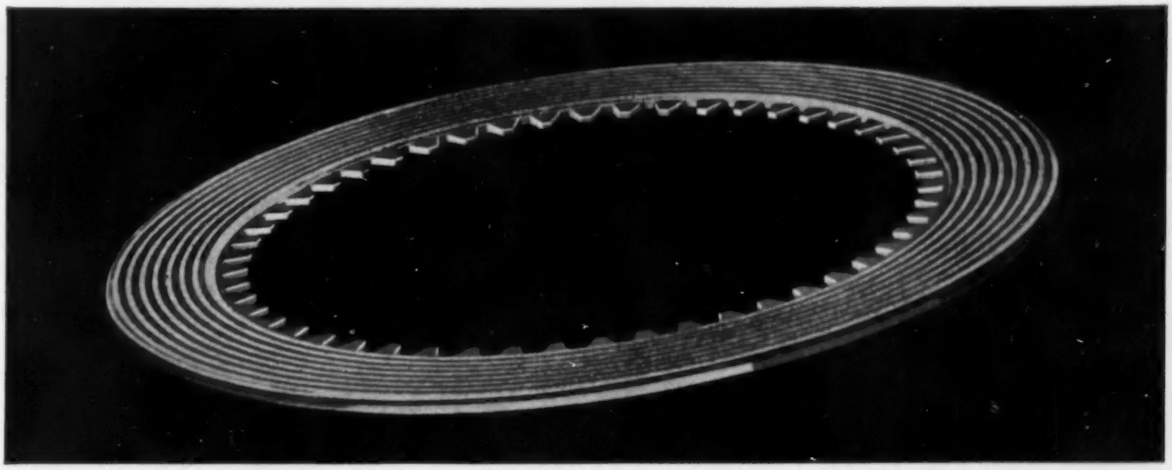


The Beechcraft T-34 is now in production for the U. S. Navy, U. S. Air Force, and the military services of Canada, Chile, Colombia, El Salvador, Japan.

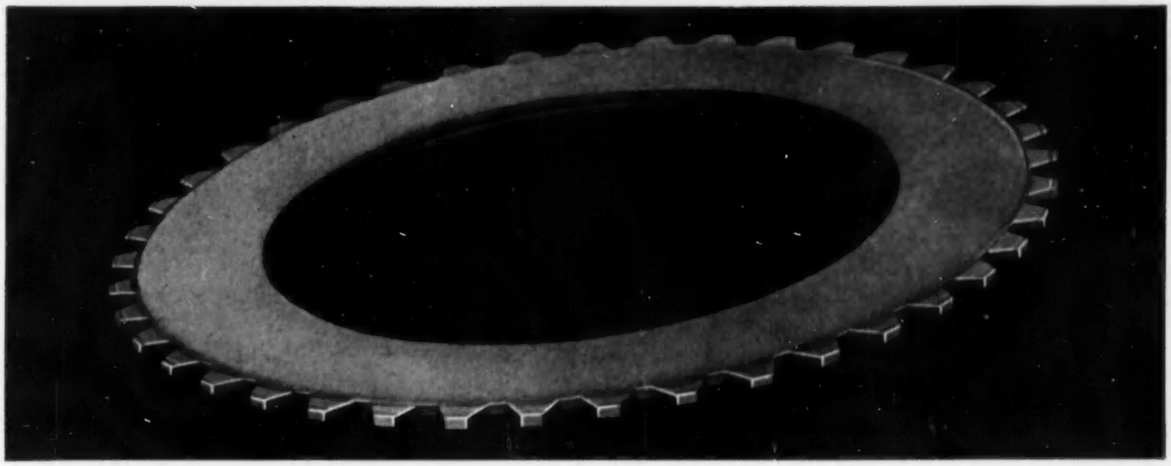
Beechcraft

Beech Aircraft Corporation, Wichita, Kansas, U. S. A.

Beech Builds: USAF T-34 • USNavy T-34 • USArmy L-23 • USAF C-45 • Model 35 Bonanza • Model 50 Twin-Bonanza • Super 18 Executive Transport



Clutch plates for modern automatic transmissions incorporate semi-metallic facings (above) or non-metallic facings, according to manufacturer's specifications.



OFFER IMPORTANT ADVANTAGES IN

many applications...

moraine friction materials

Moraine all-metallic, semi-metallic, and non-metallic friction materials resist heat, wear and corrosion in a wide variety of applications. And it's *how well* and for *how long* they do these things that makes Moraine friction materials so superior. They've proved their stable frictional properties in Powerglide, Hydra-Matic, and Dynaflow automatic transmissions. Now they're being used in heavy-duty truck transmissions, in special military vehicles and equipment, in automotive air conditioning, and in household appliances. If you have a problem involving the automatic transmission of power, Moraine's experience and ability with friction materials may be of value to you.

Other Moraine products include: Moraine-400 bearings, toughest automotive engine bearings ever made—M-100 engine bearings and Moraine conventional bi-metal engine bearings—Self-lubricating bearings—Moraine friction materials—Moraine metal powder parts—Moraine porous metal parts—Moraine rolled bronze and bi-metal bushings—Moraine power brakes—Delco hydraulic brake fluids, Delco brake assemblies, master cylinders, wheel cylinders and parts.

moraine products

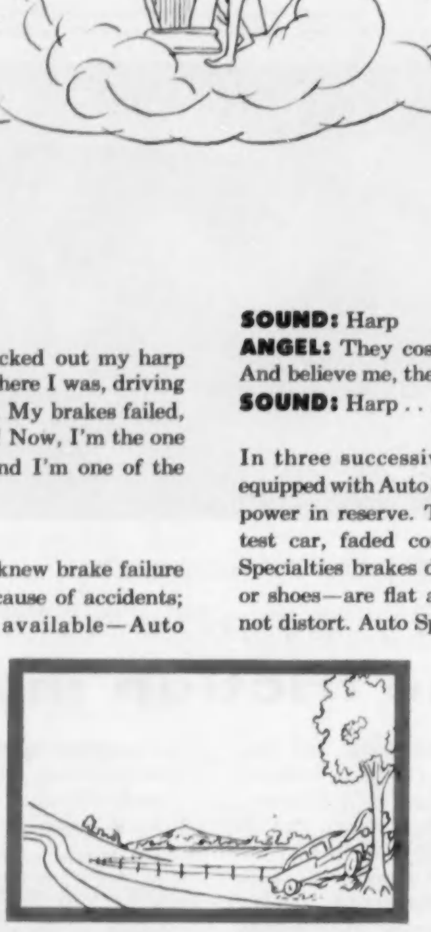
DIVISION OF GENERAL MOTORS, DAYTON, OHIO

SOUND: Harp . . . off key

ANGEL: Hi! I'm a beginner. I checked out my harp and wings right after my accident. There I was, driving around . . . a nondescript generality. My brakes failed, and just like that . . . I'm a statistic! Now, I'm the one out of 3 whose brakes failed . . . and I'm one of the ones where it was fatal.

SOUND: Harp . . . strumming

ANGEL: It could happen to you. I knew brake failure was the greatest single mechanical cause of accidents; I also knew a better brake was available—Auto Specialties Double-Disc Brakes. I didn't do anything about it—and look what happened! I was braking my car down a mountain and when I got about three quarters of the way down, there was still plenty of mountain left . . . but I was out of brake. You could drive down two mountains and still have plenty of braking power left if you had Auto Specialties Double-Disc Brakes. I never asked for Auto Specialties Double-Disc Brakes. You still can.



SOUND: Harp

ANGEL: They cost about as much as power brakes. And believe me, they're a lot cheaper than a harp.

SOUND: Harp . . . up and out. ▲ ▲ ▲

In three successive trips down a mountain, a car equipped with Auto Specialties brakes had ample braking power in reserve. The *conventional* brakes, on another test car, faded completely after the first trip. Auto Specialties brakes do not "fade." They have no drums or shoes—are flat aluminum discs which run cool—do not distort. Auto Specialties brakes stop cars smoother, safer, quicker, and surer under all driving conditions.

Auto Specialties Self-Energized Double-Disc Brakes have passed the severe testing of major car factories. Their cost is comparable to that of present automotive brakes. Their adoption will be in keeping with increased horsepower, speed and with the industry's continuing desire to give the American motorist better, safer and more pleasant means of transportation. For more information about these brakes, write:

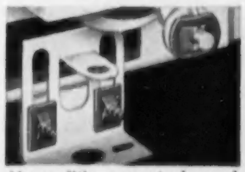
AUTO SPECIALTIES MFG. CO., INC.

SAINT JOSEPH, MICHIGAN

Plants also at Benton Harbor and Hartford, Mich., and Windsor, Ont., Canada

Manufacturing for the automotive and farm machinery industry since 1908


Flat Type SPEED NUTS cut costs of attaching auto radio speaker to baffle.


Air-conditioner control-panel assembly costs cut 40% with help of Flat Type SPEED NUTS.


Special Flat Type SPEED NUT reduced assembly time 87% on washer motor mount bracket.

This one SPEED NUT for either screw provides new savings!

If you use "A" and "Z" sheet metal screws in your product assemblies, here's good news for everyone from your design and production engineers to stock room clerks.

C7000 Flat Type SPEED NUTS work equally well on both "A" and "Z" sheet metal screws—only one type of SPEED NUT brand fastener to purchase, stock and handle. You reduce inventories, eliminate parts mixing. And you can also lower unit costs through larger quantity purchases.

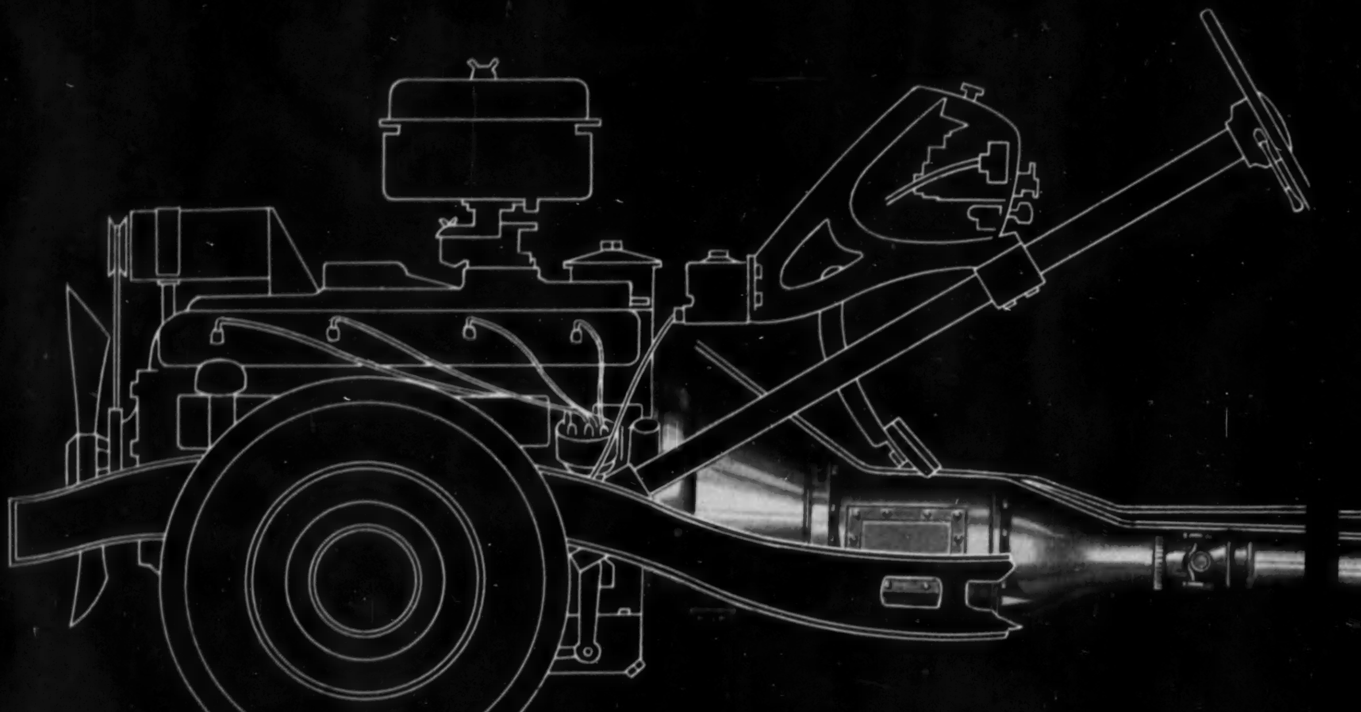
One SPEED NUT replaces three parts . . . lock washer, threaded nut and spanner washer. Yet it offers an attachment that is permanently tight until you want to loosen it!

Ask your Tinnerman representative for samples of the new dual-service C7000 Flat Type SPEED NUT . . . it's the modern way to save time and money, and avoid headaches!

TINNERMAN PRODUCTS, INC. • BOX 6688, DEPT. 12, CLEVELAND 1, OHIO
Canada: Dominion Fasteners, Limited, Hamilton, Ontario. *Great Britain:* Simmonds Aerocessories, Limited, Treforest, Wales. *France:* Aerocessoires Simmonds, S. A., 7 rue Henri Barbusse, Levallois (Seine). *Germany:* Hans Sickinger GmbH "MECANO", Lemgo-i-Lippe.

TINNERMAN *Speed Nuts*®
FASTEST THING IN FASTENINGS®

WE ARE EXPERTS IN PROP-SHAFT PROBLEMS......



DANA CORPORATION,

Fred

We've got to lower that prop shaft — better call Spicer!

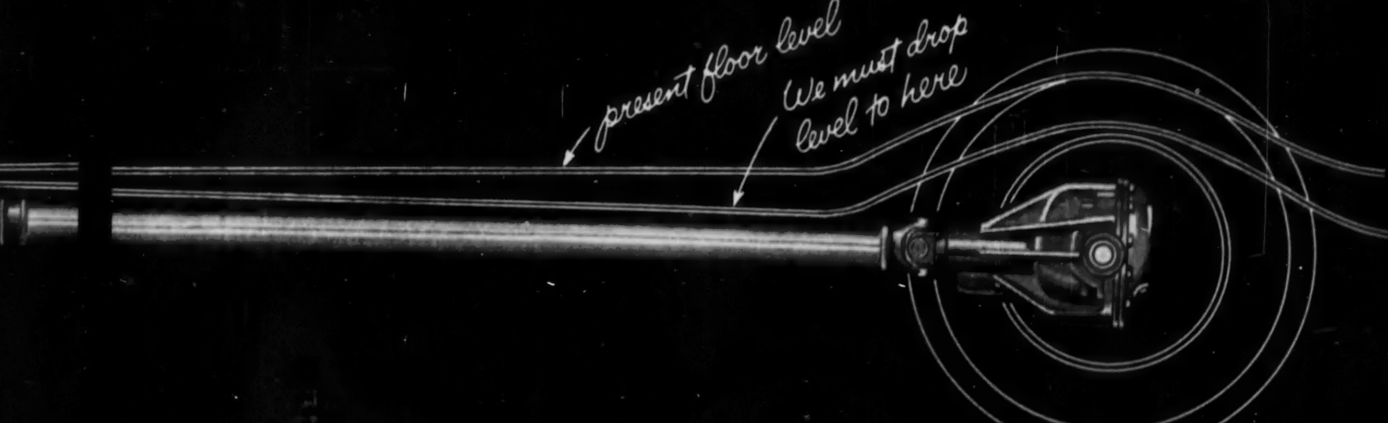
Ben

Problems of prop-shafts as related to lower floors . . . lower frames . . . engine angle . . . axle alignment . . . and other modern developments in motor, chassis and body designs . . . are welcomed by Dana.

Dana engineers are working on today's propeller shaft problems with every passenger car manufacturer, and are developing efficient Spicer designs to cover many different and complicated requirements!

Dana engineers have accumulated an invaluable fund of propeller shaft and universal joint design knowledge . . . the result of over 50 years experience in this field. Spicer originated the automotive universal joint and propeller shaft . . . and Spicer products have been built into practically every type of motor vehicle that has been manufactured.

Ask Dana to help solve your prop-shaft problems!



TOLEDO 1, OHIO

SPICER PRODUCTS: TRANSMISSIONS • UNIVERSAL JOINTS • PROPELLER SHAFTS • AXLES • TORQUE CONVERTERS • GEAR BOXES • POWER TAKE-OFFS • POWER TAKE-OFF JOINTS • RAIL CAR DRIVES • RAILWAY GENERATOR DRIVES • STAMPINGS • SPICER AND AUBURN CLUTCHES • PARISH FRAMES

Mayari R makes it lighter... stronger... longer lasting

Mammoth trailers like this one are built of Mayari R by Utility Trailer Manufacturing Company, Los Angeles, to carry loads up to 90 tons. Mayari R helps keep deadweight down to rock bottom, payloads up to peak.

Public utility line construction and maintenance body built by Baker Equipment Engineering Co., Richmond, Va., for the Virginia Electric and Power Co. Used in framing, Mayari R cut out 300 lb deadweight while adding substantially to the durability of the body under hard and continuous service.

They design and build better with Mayari-R

These are but two in an ever-widening variety of trucks and trailers that are being built better and stronger with Mayari R low-alloy, high-strength steel. In both cases Mayari R's superior strength allowed the builders to simplify designs and turn out rugged vehicles with lowered deadweight.

Used in underframes, posts, purlins, body sheets and other parts, Mayari R can save up to 40 pct in deadweight. Or, with units of the same weight, it greatly increases payload capacity.

Either way—weight-reduction or payload increase—dollar savings in operation and maintenance are the result. Ton-mile and passenger-mile costs drop. Truck and trailer freight moves more cheaply. Tire and fuel costs come down, and there is less time out for mechanical repairs.

There's a lot more to the Mayari R story, and you'll find it all attractively set down in Catalog 353. A full section devoted to automotive vehicles covers a multitude of ideas, while the charts and technical data will be helpful to your engineers. A call or letter to the nearest sales office will bring your copy promptly.

BETHLEHEM STEEL COMPANY
BETHLEHEM, PA.

On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation. Export Distributor: Bethlehem Steel Export Corporation

BETHLEHEM STEEL

In a class by itself

This rugged housing—a one-piece forging, heat-treated—is the most widely used in the world for commercial axles . . . and with sound reason: it is light in weight, yet exceedingly strong to maintain precision gears and shafts in true alignment.

It is another perennial proof that it's good business to do business with Clark

CLARK EQUIPMENT COMPANY • BUCHANAN • Battle Creek, Jackson and Benton Harbor, Michigan

CLARK® EQUIPMENT

Fits places and budgets that no other loader can!...

Clark's new Y-20-SCOOP

This little end-loader will do many of the things that bigger, more expensive machines can do—*plus a lot of things they can't do!* The Clark BULK LOADER has the shortest turning radius of any machine on the market—5'11". Within its capacity (11 cu. ft., 1200 lbs.), it's unbeatable for handling loosely packed material in cramped quarters—boxcars, narrow aisles, close approaches to hoppers.

ASK YOUR CLARK DEALER FOR A DEMONSTRATION

CLARK EQUIPMENT

There's plenty of power, plenty of traction for light shoveling, with speeds up to 8½ mph in both directions. Fully loaded, the BULK LOADER will climb a 14% grade.

Bucket action is also outstanding. Low-level independent tilt-back guarantees full bucket loads every time, permits carrying in lowered position without spillage. The 50 degree dumping action has a full 86 in. clearance under the hinge, 60 in. under the lip.

Compare the performance of this new BULK LOADER against competitive machines. And remember that you'll have no service problems with this new Clark machine—parts and components are mainly interchangeable with the standard Yardlift-20. Service is immediately available from your local Clark dealer, listed in the Yellow Pages under "Trucks, Industrial."

Industrial Truck Division
CLARK EQUIPMENT COMPANY
Battle Creek, Michigan

Send For Free Print—1912 Hupmobile "20"

For years a popular and successful car, the *1912 Hupmobile "20"* had a 16-20 H.P. four-cylinder L-head engine, multiple-disc clutch, selective transmission with two speeds forward, splash-lubricated engine, and expanding rear-wheel brakes.

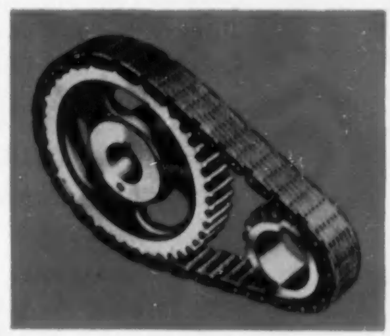
This is one of a series of antique automobile prints that will appear in future Morse advertisements. Write for your free copy, suitable for framing. Morse Chain Company, 7601 Central Avenue, Detroit 10, Michigan.

Why Morse Timing Chains are used as original equipment by 13 out of 17 automobile manufacturers

Thirteen of the seventeen automobile manufacturers who now use timing chain drives as original equipment, specify Morse Timing Chain Drives. This is true for several reasons:

(1) Morse Timing Chain Drives assure car, bus, and truck manufacturers of long, trouble-free service life—eliminate maintenance difficulties. (2) Morse Timing Chain Drives offer safe, quiet, and smooth operation, even when camshafts and crankshafts are not exactly parallel. (3) Speedy delivery of a complete line of timing chain drives helps to meet production schedules. (4) Morse offers expert engineering service to assist in solving timing chain problems of design, development, and application.

Check with Morse on your timing chain problems. Find out, too, how well other Morse Power Transmission Products can answer your needs in product design and application. MORSE CHAIN COMPANY, 7601 CENTRAL AVENUE, DETROIT 10, MICHIGAN.



MORSE

BW

CHAINS, CLUTCHES, AND COUPLINGS

FOR 24 REASONS, MASTERS OF MECHANICAL POWER TRANSMISSION SINCE 1893

KNOW-HOW . . . THE VITAL PART OF EVERY PART THAT'S BUILT BY ROHR!

ROHR has become famous as the world's largest producer of ready-to-install power packages for airplanes . . . like the all-jet Boeing B-52, Convair Liner, Douglas DC-7, Lockheed Constellation and other great military and commercial planes.

Currently, ROHR aircraftsmen are producing over 30,000 other different parts for aircraft of all kinds.

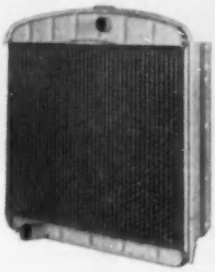
The wealth of engineering skill and production know-how gained from building these thousands upon thousands of power packages and millions of other parts is available to you. For aircraft parts better, faster, cheaper . . . call on our know-how . . . the vital part of every part that's built by ROHR.

WORLD'S LARGEST PRODUCER OF READY-TO-INSTALL POWER PACKAGES FOR AIRPLANES – *RECIPROCATING, TURBO-PROP, TURBO-COMPOUND AND JET*

ROHR AIRCRAFT CORPORATION

CHULA VISTA AND RIVERSIDE, CALIFORNIA

COOL FRONT FOR 2,000,000 "ROCKETS"!



Every "Rocket" Engine is cooled by a rugged, reliable Harrison radiator!

Over 2,000,000 "Rockets" are rolling . . . *and Harrison's doing the cooling!* It's a milestone for Oldsmobile and for Harrison, too! For right on through the high-compression era, Harrison radiators have been *out front* . . . cooling each "Rocket" Engine for peak performance! What's more, you'll find Harrison heat exchangers on the job in the air and on the sea, on the farm and in the factory—on all types of aviation, marine and industrial equipment. And with its ultra-modern engineering and research facilities, Harrison is always searching for new and better ways to do the vital cooling job. If you have a cooling problem, look to Harrison for the answer!

HARRISON RADIATOR DIVISION, GENERAL MOTORS CORP., LOCKPORT, N.Y.

TEMPERATURES MADE TO ORDER

HARRISON

Hydraulic system for farming

Shown here, is an International Harvester McCormick ***Farmall Tractor*** equipped with the *Hydra-Touch* hydraulic system. The system is so compact that it can be almost completely enclosed in the tractor body. Dependable Bundyweld Tubing promises faithful performance here, as in other installations. Absolutely leakproof, Bundyweld takes easily to intricate fabrication operations; can be bent to shortest radii.

WHY BUNDYWELD IS BETTER TUBING

Bundyweld starts as a single strip of copper-coated steel. Then it's . . . continuously rolled twice around laterally into a tube of uniform thickness, and passed through a furnace. Copper coating fuses with steel. Result . . . Bundyweld, double-walled and brazed through 360° of wall contact.

← **NOTE** the exclusive Bundy-developed beveled edges, which afford a smoother joint, absence of bead, and less chance for any leakage.

equipment relies on Bundyweld for dependable performance

The use of Bundyweld Tubing in the *Farmall 400 Tractor* (shown at left), is a typical example of the type of engineering requirements that are successfully met when Bundyweld is specified for vital gas, oil, and transmission lines and other tubing lifelines.

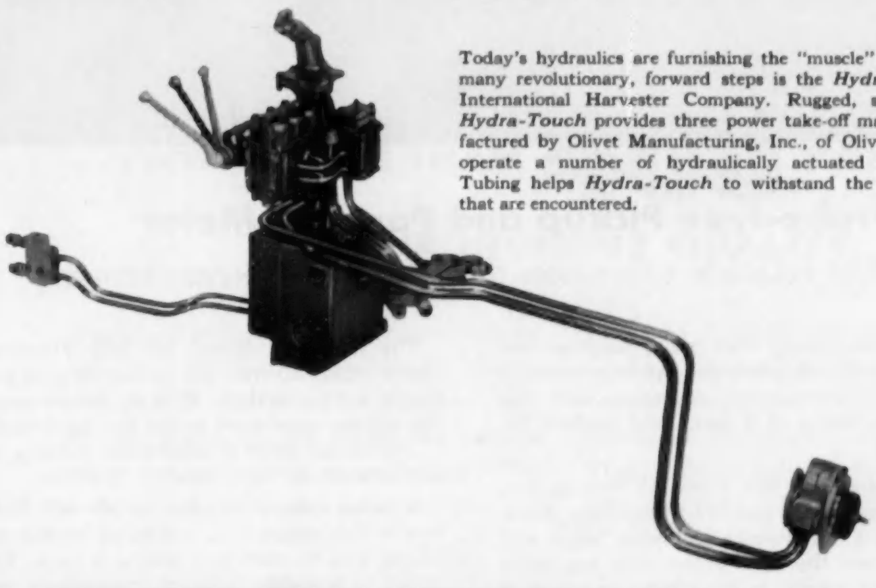
Manufacturers of farm equipment insist upon the proved dependability of Bundyweld, because their machinery must stand up under conditions of rugged terrain, bad weather, and strenuous use. These machines require sturdy tubing that won't leak, and can withstand heavy vibration fatigue and punishing wear.

Bundyweld is thinner-walled, yet stronger; it is leakproof by test, has high bursting strength, takes easily to standard protective coatings, and has a high fatigue limit. This quality tubing is double-walled, and copper-bonded through 360° of wall contact.

But you get more than quality when you deal with Bundy—for Bundy backs up the world's finest small-diameter tubing with the most advanced fabrication facilities, expert engineering help, custom packaging of orders, and prompt, on-schedule deliveries.

Follow the example of the hundreds of industrial leaders who use Bundyweld lifelines in their automobiles, trucks, buses and farm equipment. Call, write, or wire us, today.

BUNDY TUBING COMPANY
DETROIT 14, MICHIGAN



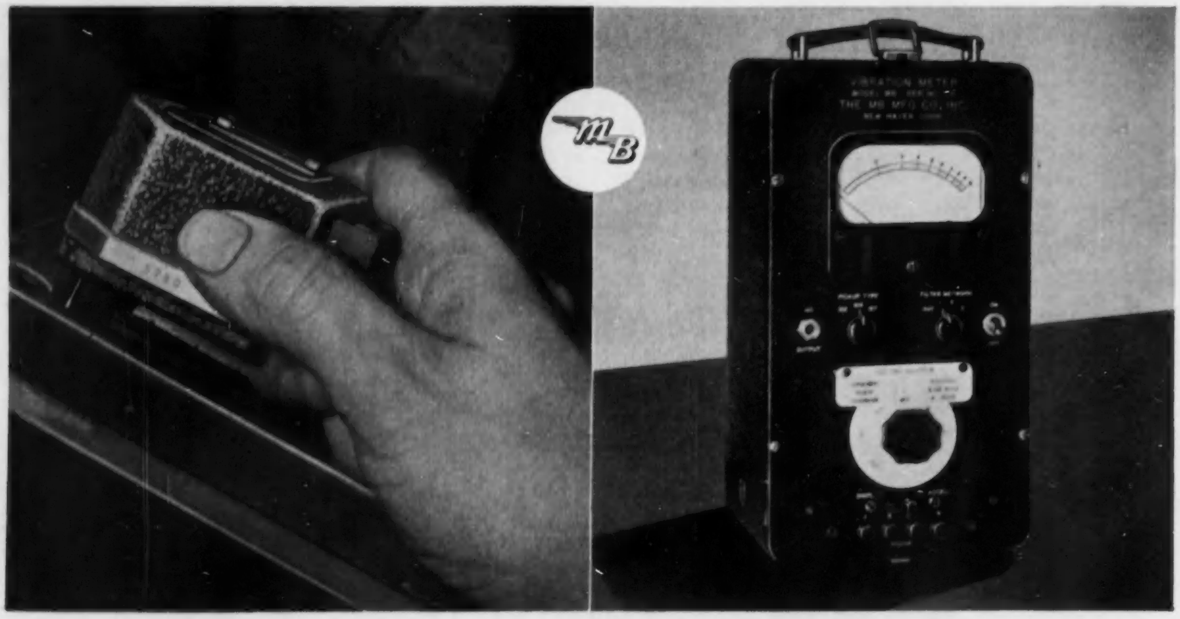
Today's hydraulics are furnishing the "muscle" on the farm. Typical of many revolutionary, forward steps is the *Hydra-Touch* system of the International Harvester Company. Rugged, simple, and dependable, *Hydra-Touch* provides three power take-off manifolds which are manufactured by Olivet Manufacturing, Inc., of Olivet, Michigan, and which operate a number of hydraulically actuated implements. Bundyweld Tubing helps *Hydra-Touch* to withstand the vibration and pressures that are encountered.

BUNDYWELD TUBING®

DOUBLE-WALLED FROM A SINGLE STRIP

Bundy Tubing Distributors and Representatives: ***Cambridge 42, Mass.:*** Austin-Hastings Co., Inc., 226 Binney St. • ***Chattanooga 2, Tenn.:*** Peirson-Deakins Co., 823-824 Chattanooga Bank Bldg. • ***Chicago 32, Ill.:*** Lapham-Hickey Co., 3333 W. 47th Place • ***Elizabeth, New Jersey:*** A. B. Murray Co., Inc., Post Office Box 476 • ***Los Angeles 58, Calif.:*** Tubesales, 5400 Alcoa Ave. • ***Philadelphia 3, Penn.:*** Ruton & Co., 1717 Sansom St. • ***San Francisco 10, Calif.:*** Pacific Metals Co., Ltd., 3100 19th St. • ***Seattle 4, Wash.:*** Eagle Metals Co., 4755 First Ave., South ***Toronto 5, Ontario, Canada:*** Alloy Metal Sales, Ltd., 181 Fleet St., E. • **Bundyweld nickel and Monel tubing are sold by distributors of nickel and nickel alloys in principal cities.**

Two new "tools" to help you pin point vibration



MB Probe-type Pickup and Portable Meter

simplify reliable vibration detection and measurement

Here's the pickup that really searches out vibration. It combines the extreme sensitivity of electromagnetic operation with the wide usefulness of a hand-held probing instrument.

With this new MB Type 115 Pickup, you can explore large panels . . . bearings, housing, structural members, bodies large and small. Since the light probe adds negligible loading or weight to the vibrating object, it translates any vibration into voltage with great accuracy for measurement. It lets you pin-point the trouble . . . determine quickly any need for corrective design.

The improved Model M6 MB Vibration Meter teams up with the pickup to give you the facts on vibration. With it, you measure the voltage generated in the pickup directly . . . in useful terms of amplitude, velocity, or acceleration of the vibratory motions.

You can connect as many as four MB Pickups to this meter . . . a selector switch enabling you to read any one at a time. The meter is portable, compact, ruggedized and operates on standard AC.

To lick vibration, you've got to locate it first. You'll find this pair a big help for that job. Write for more data.

the MB manufacturing company, inc.

1060 State Street, New Haven 11, Conn.

HEADQUARTERS FOR PRODUCTS TO ISOLATE VIBRATION...TO EXCITE IT...TO MEASURE IT

AUTO-LITE SERVES INDUSTRY

. . . WITH MORE THAN 400 PRODUCTS

OF THE HIGHEST QUALITY

From the early days of the automotive industry, Auto-Lite has earned a reputation for building products of the highest quality and dependability for cars, trucks, tractors, planes and boats, as well as for our government and industry. That quality is reflected in the public acceptance of the name Auto-Lite—the best-advertised name in the automotive aftermarket. It is reflected, too, in the established Auto-Lite service facilities throughout the world. Today's buyers know "You're Always Right . . . With Auto-Lite."

THE ELECTRIC AUTO-LITE CO., Toledo 1, Ohio

AUTO-LITE *Manufacturers of...*

BATTERIES • BUMPERS & GRILLES • CASTINGS—Gray Iron, Zinc and Aluminum • HEADLIGHT DIMMERS • FUEL PUMPS • GENERATORS HORNS • IGNITION UNITS • INSTRUMENTS & GAUGES • LIGHTING UNITS • METAL FABRICATED ASSEMBLIES • MOTORS—AUTOMOTIVE FRACTIONAL • STARTING MOTORS • SPEEDOMETERS • SPEEDOMETER CABLE • PLASTICS • SEAT AND WINDOW MOVING MECHANISMS SPARK PLUGS • SWITCHES • WINDSHIELD WIPERS • WIRE & CABLE

"Torture-Testing" Builds Axles that can take it. In our indoor proving ground, we have concentrated every hazard of a million miles of driving. TDA axles prove themselves against tests like this one . . . where an axle shaft is twisted 14° backwards and forwards, 36 times a minute, for months on end. Other tests simulate a 3,000 mile uphill haul with a full load. Only tests this rugged could produce axles this serviceable.

HEAVY LOADS ARE PAYLOADS

...and exclusive Timken Inter-Axle cab controlled lockout at any speed!

Every heavy trucker has two big problems to lick. First, to deliver more payload faster. Second, to get the most service out of his equipment . . . with less maintenance costs, less downtime.

Timken-Detroit has spent 37 years developing the most helpful answer to heavy hauling! The TDA Tandem Drive Rear Axle Unit! The lightest, strongest, most serviceable unit of its kind ever produced.

Engineering is the keynote of TDA Tandem superiority. Unlike ordinary tandems, in TDA Straight Line Drive, propeller shafts form an absolutely straight line from the forward rear axle back to the rearmost axle. This permits smoother transmission of power, no noisy *around the corner operation*.

Other TDA Tandem design advantages give you longer trouble-free service, quieter, more economical performance, bigger savings on man and equipment time. Maintenance is easier, too. TDA design allows almost complete interchangeability of parts between four and six-wheelers. Solid benefits explain why TDA is the choice of manufacturers and operators everywhere.

How TDA Inter-Axle Differential cuts truck and tire wear! With cab-controlled lockout!

When tandem tires are mismatched...or when tandem trucks are going over rough grades . . . one set of wheels must turn faster than the other or be dragged. TDA Inter-Axle Differential permits either wheel to do this when necessary. Also, with TDA, the driver can, when necessary, lock out the differential and obtain a straight-through drive in mud or sand.

THREE TYPES: Hypoid-helical double-reduction, optional inter-axle differential. Worm drive, without inter-axle differential.

For six-wheeler operation . . .

THE TDA TANDEM DRIVE REAR AXLE UNIT

Now—the *world's finest* tandem drive rear unit for heavy-duty motor trucks!

And with these features, developed, introduced and pioneered by TDA: (1) Available in 3 types of final drives and 3 capacities. (2) Top-mounted straight-line final drive eliminates propeller shaft angularity. (3) Optional inter-axle differential . . . spur gear design, cab-controlled power-lockout. (4) Torsion flow axle shafts . . . guaranteed for 100,000 miles or three years, whichever occurs first. (5) Hot forged steel axle housing . . . guaranteed for the life of the vehicle. (6) Unit-mounted "P" series power brakes . . . for longer life, greater economy and efficiency. (7) Cradle ride spring suspension and paralleled torque rod system . . . maintain correct alignment and weight distribution regardless of driving and braking conditions. (8) Exclusive two-piece trunnion tube bracket speed servicing. (9) Removable torque rod and spring guide brackets . . . for positive alignment, easier replacement. (10) Rubber torque rod bushings and rubber spring seat bushings . . . eliminate metal-to-metal contact. Require no lubrication.

S | WITH TDA TANDEMS

le | *Differential that permits*

d!

TIMKEN *Detroit* AXLES

TIMKEN DETROIT AXLE DIVISION

ROCKWELL SPRING AND AXLE COMPANY

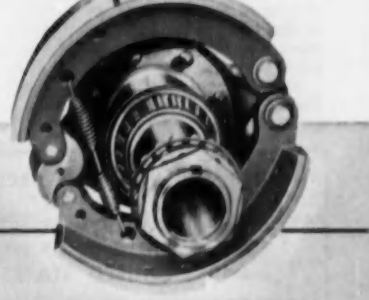
DETROIT 32, MICHIGAN

The Accepted TDA CO *Standard*

TRADE MARK REGISTERED

World's Largest Manufacturers of Axles for Trucks, Buses and Trailers

Plants at: Detroit, Michigan • Oshkosh, Wisconsin • Utica, New York • Ashtabula, Kenton and Newark, Ohio New Castle, Pennsylvania



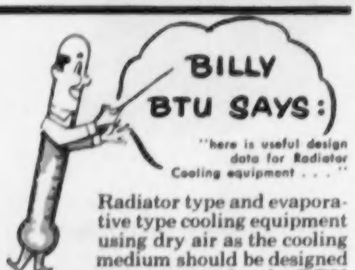
ONLY TDA BRAKES give all these tested advantages!

- Brake shoes made of steel save up to 40 pounds per axle . . . give strong braking action with no distortion.
- Patented liner shape—thickest where wear is greatest.
- Liners riveted on—no chance of movement on shoe.
- Liners circle-ground to cover all efficient braking area of shoe.
- Rustproofed anchor pins locked in. Ends of pin sealed against foreign matter.
- First with self-aligning camshaft housings.
- Cam rollers heat-treated to roll smoother, wear longer.
- First with all-Nylon camshaft bushings.
- Compare similar products part for part and prove to yourself that TDA brakes incorporate the finest quality materials, skilled workmanship and advanced design.

Young Heat Transfer News

YOUNG RADIATOR COMPANY, RACINE, WIS.

Allis-Chalmers *SPECIFIES* Young Radiators for models CA and WD-45 Tractors

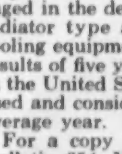


Radiator type and evaporative type cooling equipment using dry air as the cooling medium should be designed to operate under the DRY BULB air temperatures to be expected during the summer in the locality where the equipment is to operate. Equipment using cooling effect due to water evaporation is designed to operate under the WET BULB air temperatures to be expected.

For proper design, it is not satisfactory to use either the maximum air temperature, nor the average air temperature. Use of the maximum air temperature for design would result in the selection of cooling equipment too large to be economical, since it would be fully loaded only under the most extreme temperature conditions. Use of average temperature for design purposes would result in selection of equipment too small to handle the cooling load during a great portion of the operating time. It is necessary, therefore, to use some figure between maximum and average air temperatures.

The Young Radiator Company has prepared and offers to engineers engaged in the design and application of radiator type and evaporative type cooling equipment, data taken from the results of five years of summer records in the United States. This data may be used and considered as applying to an average year.

For a copy of this data, write for Bulletin 654, Young Radiator Company, Racine, Wisconsin.



WRITE FOR FREE DESIGN TEMPERATURE BULLETIN OF THE UNITED STATES

Helpful four-page Bulletin briefly discusses atmospheric cooling equipment design temperatures for the United States. Wet and dry bulb maps are fully illustrated with isothermal lines. Write Young Radiator Company, Dept. 115-F, Racine, Wisconsin.

Drawn Tank Radiators Meet All Tractor Cooling Loads

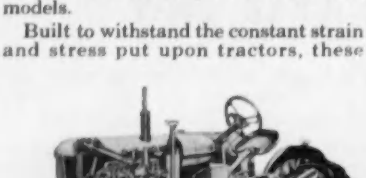
Allis-Chalmers Manufacturing Company, West Allis, Wisconsin, uses Young Radiator Company drawn tank Radiators on two powerful tractor models.

Built to withstand the constant strain and stress put upon tractors, these Young units must cope with high internal water impact pressures due to sudden starting and stopping.

To overcome these and other torsional stresses and long term vibrations, full wrap-around type terne plate side members secure tanks, headers and core as one piece. Brass top and bottom tanks are formed as one piece and have die-formed beads for reinforcement. Fabricated brass inlet with maximum flow area provides minimum resistance to coolant circulation.

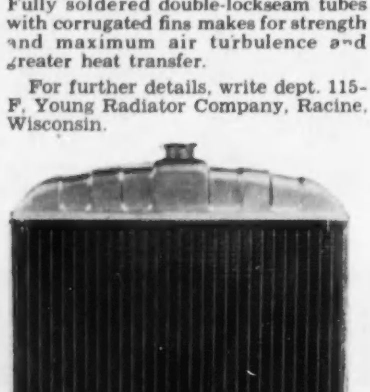
This Radiator also features Young patented double-grip, two-way headers with lapped joint solder sealed to tanks as a permanent, leak-proof assembly. Fully soldered double-lockseam tubes with corrugated fins makes for strength and maximum air turbulence and greater heat transfer.

For further details, write dept. 115-F, Young Radiator Company, Racine, Wisconsin.



Cross-sectional view of Allis-Chalmers Model WD-45 Tractor with Young Radiator.

View of Allis-Chalmers CA Tractor and forage harvester making grass silage.



Young Radiator Company drawn tank Radiator used on Allis-Chalmers Model CA Tractor.

Young RADIATOR COMPANY

RACINE, WISCONSIN

Creative HEAT TRANSFER ENGINEERS FOR INDUSTRY

Heat Transfer Products for Automotive, Aviation and Industrial Applications. Heating, Cooling, Air Conditioning Products for Home and Industry.

Executive Office: Racine, Wisconsin, Plants at Racine, Wisconsin, Mattoon, Illinois

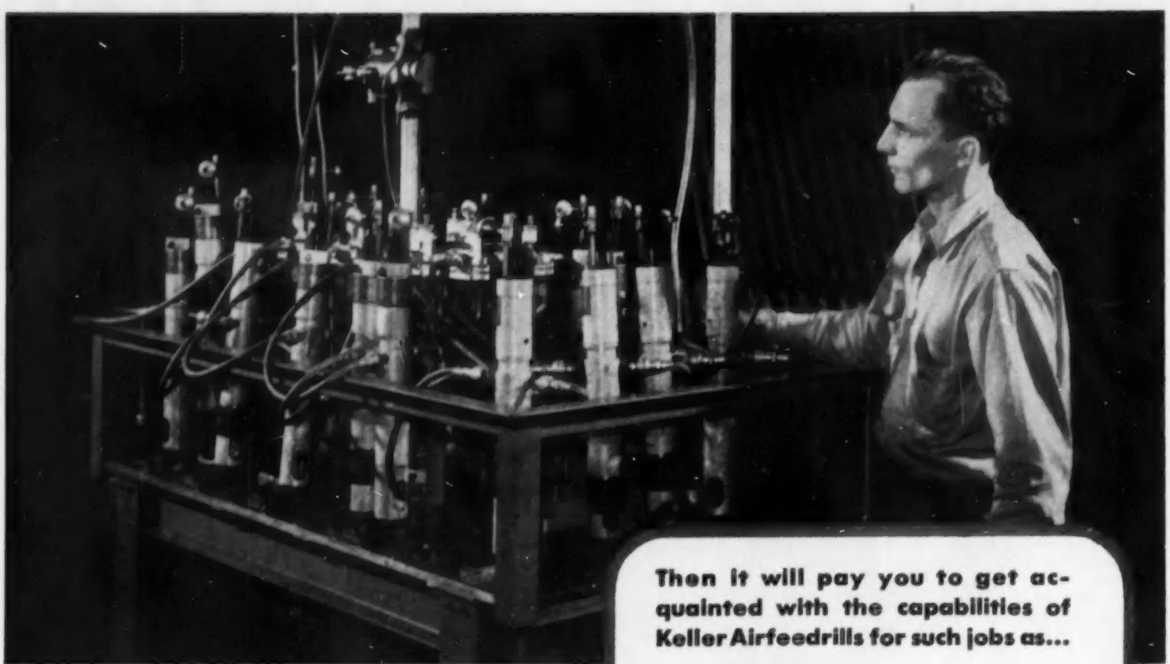
McQUAY-NORRIS

PISTON RINGS

Since 1910, McQuay-Norris has played a leading role in the piston ring field. This background of more than 43 years experience is available to manufacturers who require engineering and production skills of the highest standard.

McQUAY-NORRIS MFG. CO. • ST. LOUIS 10, MO.

Can automatic production help you improve quality . . . reduce costs ?



A typical automatic production setup using 14 Keller Airfeedrills. Pressing a single control valve drills 14 holes simultaneously in a refrigerator outer shell assembly—the drills advance, drill, retract, and shut off automatically.

Then it will pay you to get acquainted with the capabilities of Keller Airfeedrills for such jobs as...

- **DRILLING**
- **REAMING**
- **COUNTERSINKING**
- **TAPPING**
- **CENTER DRILLING**
- **CHAMFERING**
- **COUNTERBORING**
- **SPOTFACING**

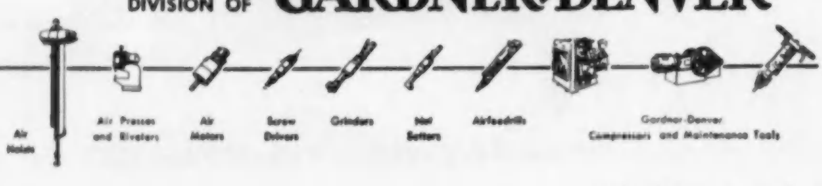
These remarkable tools work without supervision, and take the place of expensive machines in automation setups. They are entirely air controlled and operated, automatically cycled, and extremely accurate.

Among the special advantages available are sensing type rapid advance, hydraulic feed control, and adjustable torque control. Thus they are able to do peck drilling, skip drilling, and other jobs that heretofore have required expensive machine tools.

Write and tell us about your machining problems. We will send appropriate bulletins or have a representative call to discuss Keller Air Tools.

KELLER TOOL

DIVISION OF **GARDNER-DENVER**



GRAND HAVEN, MICHIGAN

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Steering Post Bracket Insulator
Spark Plug Covers
Steering Post Pads
Radiator Drain Tube
Silent Block Bushing
Tail Pipe Insulator Support
Wiper Hose
Antenna Gaskets
Division Channel Weatherstrip
Window Channel Filler Seal
Parking Light Lens Gaskets
Bumper to Fender Spacer
Fresh Air Adapter Grommets
Battery Drain Tubes
Gearshift Lever Arm Bushing
Replacement Tubes
Frame & Axle Bumpers
Spring Shackle Bushings
Fender & Engine Compartment Dust Shield
Steering Wheel Spoke Ornament Cushion
Instrument Panel Anti-Squeaks, Wiring Grommets
Windshield Wiper Pivot Pad & Bracket Grommet
Rear Window Weatherstrips
Horn Ring Ornament Cushion
Dash Liner & Cowl Trim Pads
Door Check Arm Bumpers
Stone Deflector Bumper
Sound Deadener Insulation
Tubeless Tires
Wiring Clips
Body Shims
Headlight Lens Gaskets
Radiator to Hood Seals
Tail & Stop Lamp Lens Pads
Radiator Seals
Hood Lacing
Fender Seals
Hood Bumpers
Bumper Grommet
Glove Box Door Bumpers
Gas Tank Filler Neck Grommet
Sill Mats & Attaching Grommets
Defroster Hose
Door Bumpers

over 100 parts made from Enjay Butyl now used in '55 models

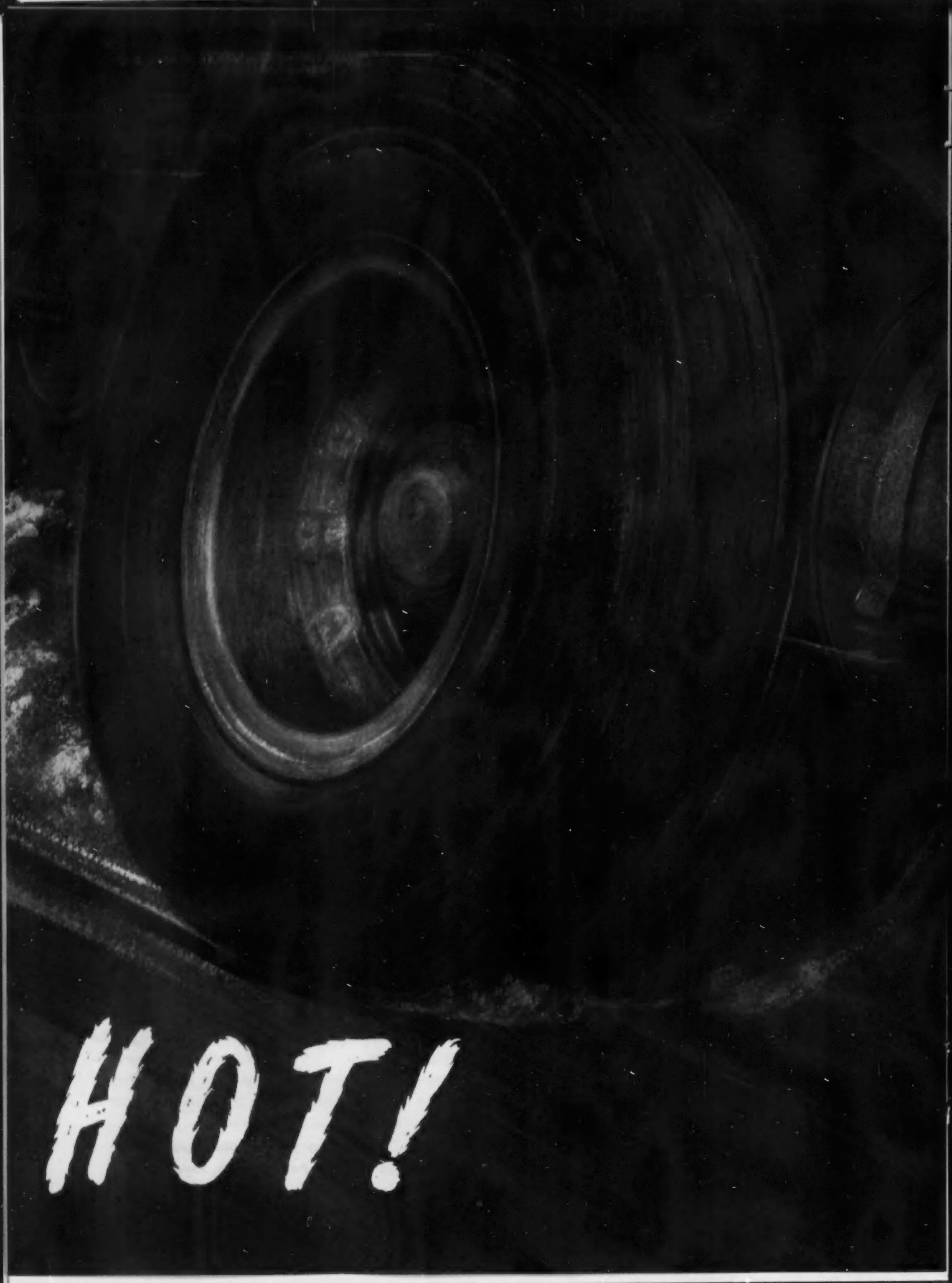
This car, like many other 1955 models, is setting new standards of performance and appearance. It is protected in vital places by parts made from Enjay Butyl—the super-durable rubber that outperforms and outlasts other types of rubber used in similar applications.

Enjay Butyl is amazingly resistant to weather, wear, and deterioration. It does not crack, chip, or lose its resiliency even under extreme conditions of use and climate. Butyl parts *stay* like *new*.

Butyl was developed exclusively by affiliates of the Enjay Company, Inc., and is now available in *new* non-staining grades for white and light-colored automotive parts. For full information and for technical assistance in the uses of Enjay Butyl, contact the

Enjay Company, Inc., 15 W. 51st St., New York 19, N. Y.
District Office: 11 South Portage Path, Akron 3, Ohio.

ENJAY
BUTYL


HOT!

Braking big wheels won't burn

SIRVENE H-T Oil Seals

Now generally available, C/R's new sealing material resists temperatures up to 350° F.

Why the heat's on—Bigger engines, higher speeds, faster deceleration . . . these factors have pushed up temperatures in brake drums, axles, pinions and transmissions. Burn-out of oil seals has become a costly problem. With miles per year jumping to 120,000 and more, maintenance men know that standard oil seals can't take the heat, won't go the distance required on today's high-mileage fleets.

C/R research solves it—Sirvene HT Oil Seals are available in a series of high temperature synthetic rubber compounds developed from special polymers for exceptionally hot applications. They seal effectively at temperatures up to 350° F. With a longer service life than any previously known heat-resistant sealing material, Sirvene HT Oil Seals mean big savings for operators of trucks, buses, tractors, road machinery, automobiles and aircraft.

Five years of proved performance—Five years ago, exhaustive testing in C/R Research and Engineering Laboratories indicated the exceptionally high heat resistance and long service potential of Sirvene HT Oil Seals. Since then the dependability of these seals has been consistently demonstrated in aircraft, truck, road machinery and related applications.

Facts for engineers—Starting twenty years ago, Chicago Rawhide pioneered the development of high temperature sealing elements. First, Sirvis leather, then Sirvene (synthetic rubber) compounds which sealed effectively at 250° F. Now engineers may have the complete facts on this newest series of high temperature compounds.

Chicago Rawhide's unequalled oil seal development experience and facilities are also at your service. Please write.

C/R

PERFECT

Oil Seals

More automobiles, farm equipment and industrial machines rely on C/R Oil Seals than on any similar sealing device.

CHICAGO RAWHIDE MANUFACTURING COMPANY

1301 Elston Avenue OIL SEAL DIVISION Chicago 22, Illinois

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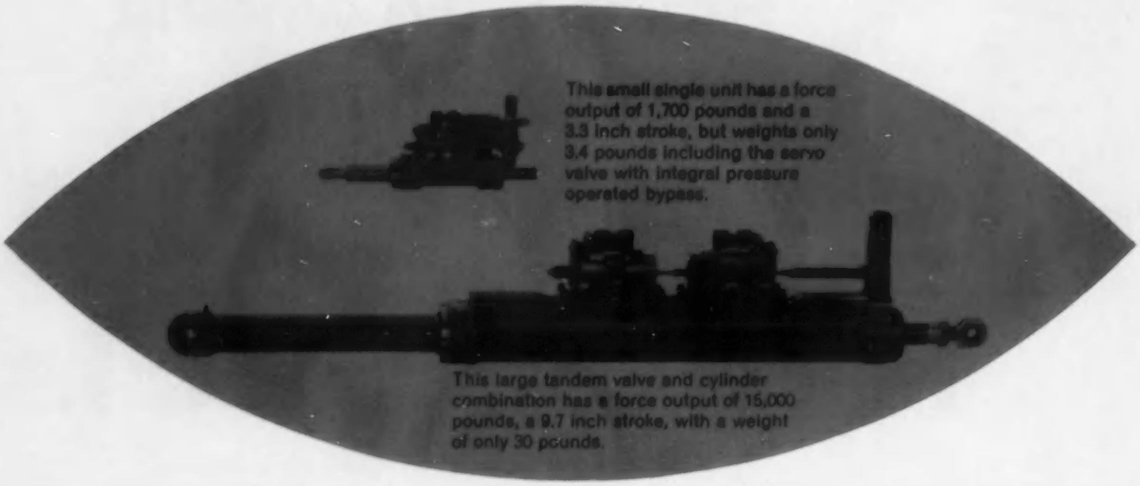
EXPORT SALES: GEON INTERNATIONAL CORP., GREAT NECK, NEW YORK

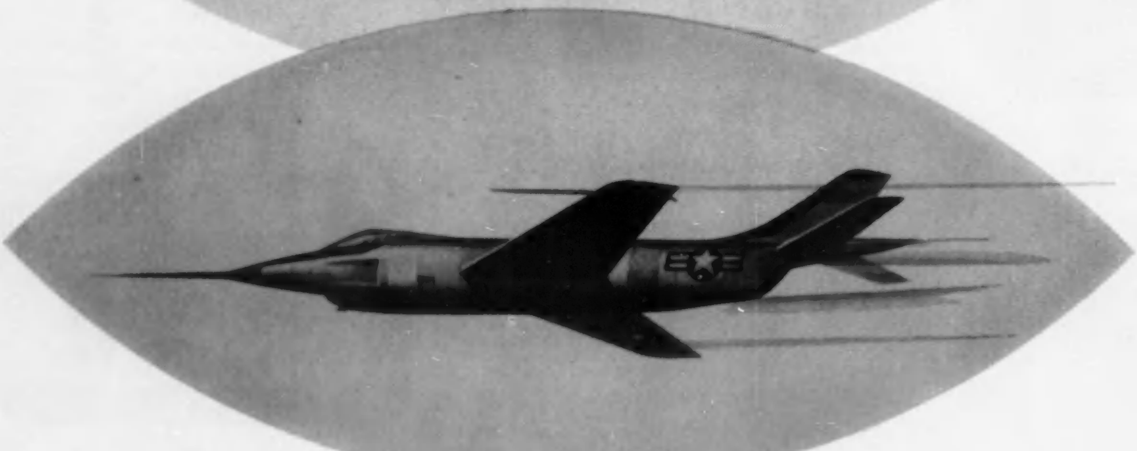
Other C/R products

SIRVENE: (Synthetic rubber) diaphragms, boots, gaskets and similar parts for critical operating conditions • CONPOR: Controlled porosity mechanical leather packings and other sealing products • SIRVIS: Mechanical leather boots, gaskets, packings and related products.



LARGE OR SMALL...QUALITY COMES FIRST

Large or small, single or tandem, Weston makes servo power control cylinders that embody the highest standards of workmanship. Many Weston units have more than 1,500 separate inspections, tests, and measurements of dimensions and performance before they are released for shipment. This extreme care is one reason more than 90% of the major airframe manufacturers use Weston hydraulic units



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HYDRAULICS
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products ...

VALVES: SOLENOID SELECTOR, MANUAL SELECTOR, REGULATOR, SHUT-OFF, BRAKE, AND SERVO; HYDRAULIC POWER CONTROL CYLINDERS, ACTUATING CYLINDERS; PNEUMATIC CONTROL UNITS, ETC.

"Wagner Air Brakes

...keep brake maintenance costs low because they are so dependable."

says: R. J. CUMMINS, Maintenance Control Supervisor, Foster Freight Lines, Inc., Indianapolis, Ind.

FOSTER FREIGHT LINES · INC.

General Office · 1240 South Holt Road · Indianapolis, Indiana

BElmont 1511

service ... all along the line

Wagner Electric Corporation
6400 Plymouth Avenue
Saint Louis 14, Missouri

Gentlemen:

"Faster by Foster" is the motto that keynotes the "One Handling Freight Service" we provide in Indiana, Ohio, Kentucky, Missouri and Illinois. Our customers can be assured 'on schedule' delivery of cargo because of our modern operation. This service policy carries through our whole set-up—from an automatic dragline in our terminal to the specifying of reliable, economical air brakes for our tractor and multiple trailer units.

Approximately 80% of our present power units are equipped with Wagner Air Brakes. In the years we've been using the Wagner Rotary Air Compressor, many of them have operated efficiently for unusually long periods of time without failure or need for repair. Wagner Air Brakes are quiet in operation, have fast air pressure recovery and keep brake maintenance costs low because they are so dependable.

We definitely plan to continue to order Wagner Air Brakes as original equipment.

Very truly yours,

R. J. Cummins
Maintenance Control Supervisor

Meeting 'on-the-road' schedules, assuring maximum cargo and equipment safety and keeping maintenance costs at a minimum are major responsibilities for all fleet operators. You can see from Mr. Cummins' letter how his company's operation benefits from the dependability of WAGNER AIR BRAKES.

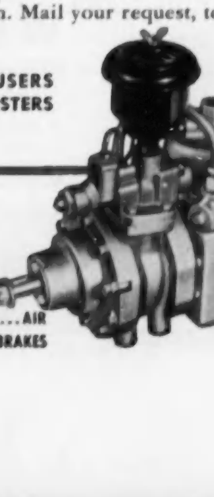
Actual checks with fleet operators have clearly shown that many units equipped with WAGNER AIR BRAKE SYSTEMS never have compressor failure or require compressor exchange—even after *years* of service. This high performance record is largely due to the superiority of the WAGNER ROTARY AIR COMPRESSOR. It is the *only* compressor utilizing *rotary motion* to keep friction loss low and operating efficiency high. Because of its fast air recovery, users are assured an adequate supply of air pressure at all times. This feature alone guarantees safe, sure stopping power to meet any road emergency.

WAGNER ROTARY AIR COMPRESSORS eliminate carbon formation in air lines and reduce fire hazard. Uniform torque load provides smooth, quiet operation with moderate stresses. Parts are interchangeable and only a minimum of preventive maintenance is required.

Because of the ever-increasing demand for greater road and cargo safety and maintenance economy, it will pay you to include Wagner Air Brakes as standard equipment on the vehicles you manufacture.

Send for your free copy of Wagner Bulletin KU-201 for full information and complete details. It will be sent to you without cost or obligation. Mail your request, today.

WAGNER AIR BRAKE USERS ARE OUR BIGGEST BOOSTERS



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K55-10A

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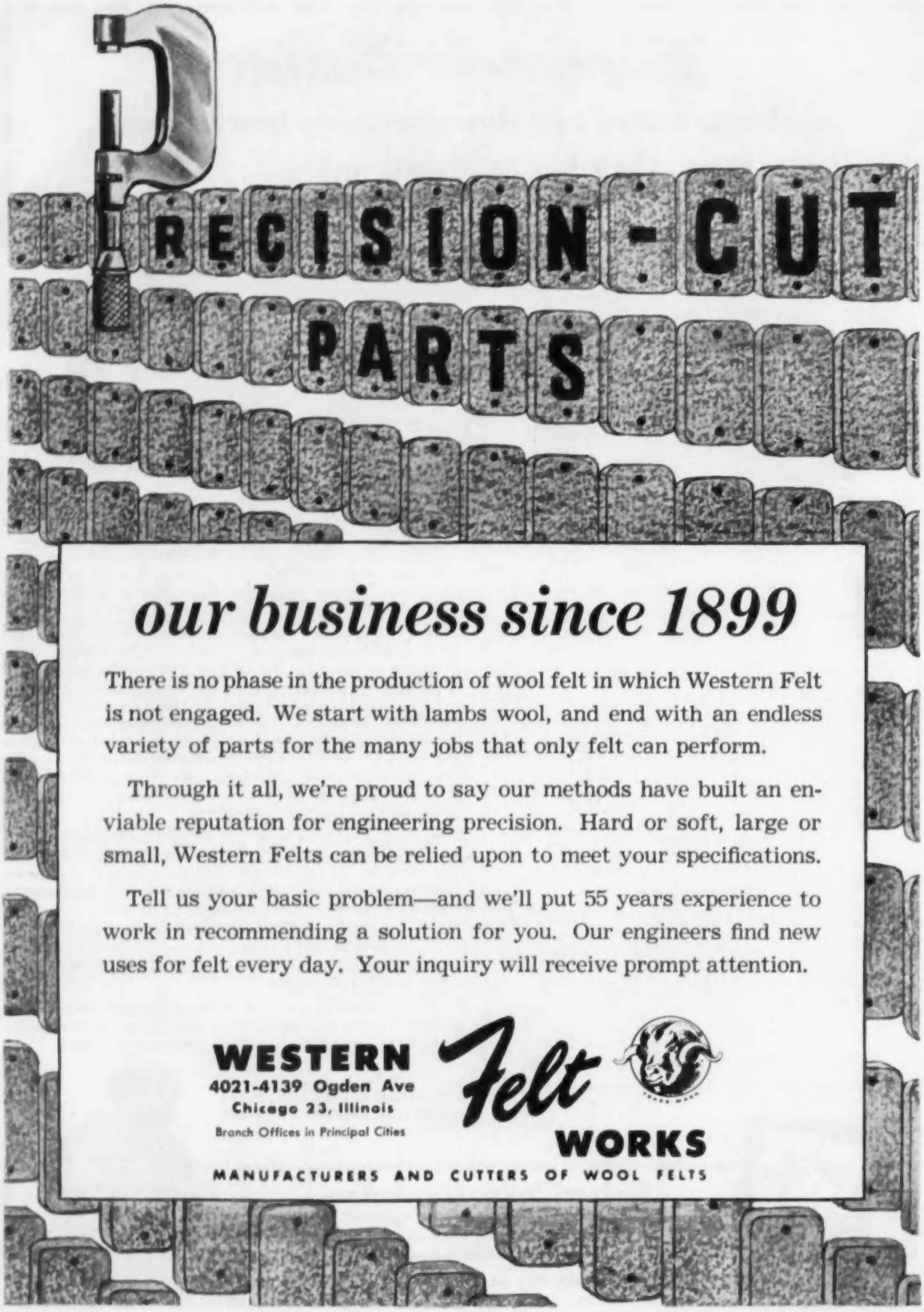
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PARTS
our business since 1899
There is no phase in the production of wool felt in which Western Felt is not engaged. We start with lambs wool, and end with an endless variety of parts for the many jobs that only felt can perform.
Through it all, we're proud to say our methods have built an enviable reputation for engineering precision. Hard or soft, large or small, Western Felts can be relied upon to meet your specifications.
Tell us your basic problem—and we'll put 55 years experience to work in recommending a solution for you. Our engineers find new uses for felt every day. Your inquiry will receive prompt attention.
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Packard's large staff of experienced engineers is at your service to help solve cable problems most efficiently. And when the problems are solved and your needs determined, Packard Electric—with facilities for the daily production of more than 7,000,000 feet of cable and 800,000 wiring assemblies—will assure you dependable, on-time delivery.

Consider Packard as a source

Packard cable and wiring harnesses meet or exceed applicable specifications. They have proved themselves time and again in meeting and standing up to the most exacting demands in automotive and aircraft service. Packard Electric's experience, skill and productive ability often result in substantial savings to customers. Possibly the savings to you could be substantial too.

GM GENERAL MOTORS

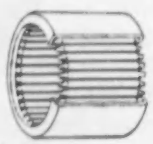
Packard

Packard Electric Division, General Motors, Warren, Ohio
Offices in Detroit, Chicago, and Oakland, California

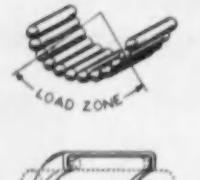
AVIATION, AUTOMOTIVE AND APPLIANCE WIRING

TORRINGTON

DC needle bearings give high-capacity performance in minimum space



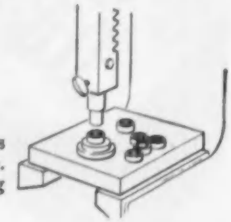
Unique construction—accurately drawn, surface-hardened shell retains rollers and serves as outer raceway.



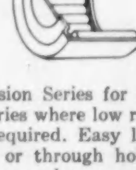
Full complement of small diameter rollers—precision-ground and through-hardened—assures top capacity by distributing load over large number of contacts.

Turned-in lips of the case-hardened outer shell keep dirt and grit out, lubricants in—while retaining trunnion ends of rollers. All wear surfaces of outer race are case-hardened.

No inner race required on surface-hardened shafts—reduces space requirements, lowers unit costs.



Simple assembly—arbor press seats bearing in round housing bore. No collars, shoulders or retaining rings needed.



Closed end type DC Needle Bearings are available for stub shaft applications. The closed end provides a perfect seal at no extra cost.

Needle Bearings are made in a Precision Series for most applications and an Extra Precision Series where low radial play and minimum eccentricity are required. Easy lubrication through optional hole in shell or through hole in shaft assures long service life. Bearings can be pre-packed with suitable grease for those applications requiring grease lubrication.

See our new Needle Bearing Catalog in the 1955 Sweet's Product Design File—or write direct for Catalog No. 55.

THE TORRINGTON COMPANY
Torrington, Conn. **South Bend 21, Ind.**

District offices and distributors in principal cities of United States and Canada

TORRINGTON *NEEDLE* BEARINGS

Needle • Spherical Roller • Tapered Roller • Cylindrical Roller • Ball • Needle Rollers

Bendix-Westinghouse AIR BRAKES

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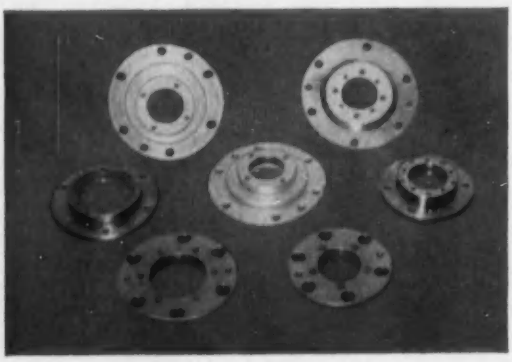
HIGH SPEED SHAFT SEALS and PISTON RINGS for both JET and RECIPROCATING AIRCRAFT ENGINES.

ORIGINAL EQUIPMENT IN ALLISON, PRATT & WHITNEY, WRIGHT and other leading AIRCRAFT ENGINES

HIGH SPEED SHAFT SEALS



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felt.. molded into special shapes

STRIP OF FELT FROM THE MOLDING PRESS

Actual molded felt part as delivered to a customer.

• American felts are moldable felts. Molded felt parts eliminate fabricating problems of stitching, cementing or stapling. They also provide one-piece integrated assemblies at lower cost for superior service where a compact, permeable shaped part is needed which will breathe, cushion, filter, seal, wick or lubricate. Review your material requirements and let our engineers apply this property of felt to your new design projects or to existing parts.

Write for our recommendation of a molded American Felt part to your specifications.

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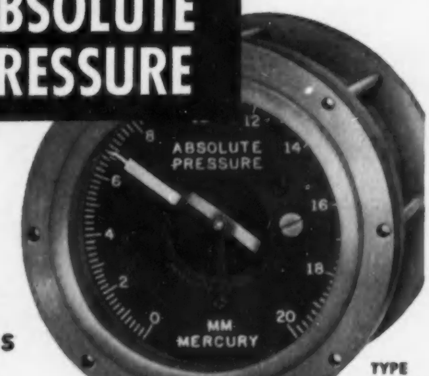

From 100 Microns Up

TYPE FA-160

... Ranges: 0.1–20 mm thru 800 mm Hg absolute in six ranges.
... Accuracy: 1 part in 300 over full scale.
... Sensitivity: 1 part in 500 in *all* ranges.
... Available with 2¾" or 6" dia. dial.

Write for Publication No. TP-28-A A-105

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PRECISION INSTRUMENTS AND ELECTRICAL MECHANISMS
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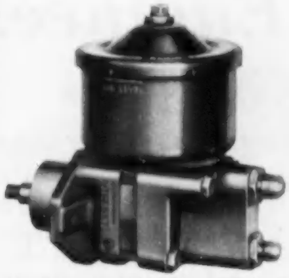
In Canada: Wallace & Tiernan, Ltd., Toronto

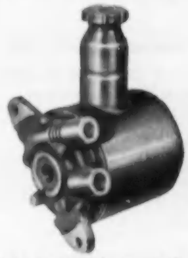
MORE VICKERS® Designed PUMPS

than all other makes combined are used for

HYDRAULIC POWER STEERING



Series VT11 Vickers Automotive Power Steering Pump with integral volume control and relief valve and oil reservoir.



Series VT21 Vickers Automotive Power Steering Pump has pumping unit together with integral volume control and overload relief valve located inside the oil reservoir to save space and weight. Arranged for economical mounting directly on generator or other accessory.

As the sleek modern automobiles roll over the highways, more and more of them have hydraulic power steering. Power Steering has caught the interest of practically all motorists. Demand for it is rocketing.

More Vickers Designed Pumps are used for hydraulic power steering than all other makes combined because Vickers Pumps have the quality and characteristics needed. Hydraulic balance eliminates pressure-induced bearing loads. Pressure compensation maintains optimum running clearances. The result is exceptionally long life with a minimum of attention required. High operating efficiency means less heat. They deliver ample power over a very wide range of operating speeds.

There is a Vickers Pump to meet any automotive power steering requirement. We shall be glad to discuss your needs.

FOR DEPENDABLE HYDRAULIC POWER MAKE SURE YOUR CARS HAVE . . .

VICKERS® HYDRAULIC PUMPS

Vickers has been building Hydraulic Power Steering Equipment for more than 25 Years

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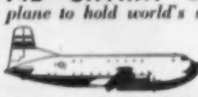
F4D "SKYRAY" *Only carrier plane to hold world's speed record*



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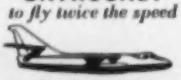

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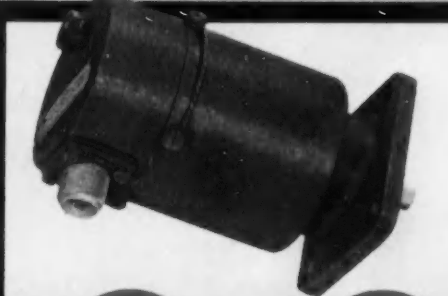

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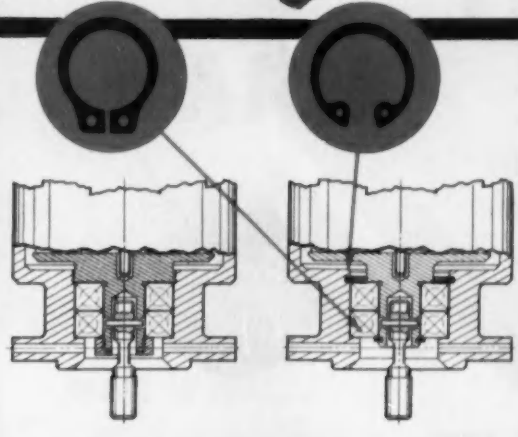

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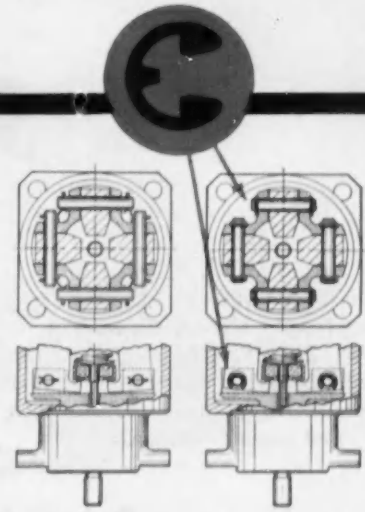

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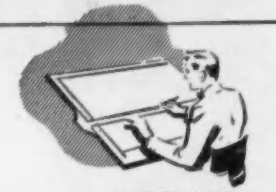

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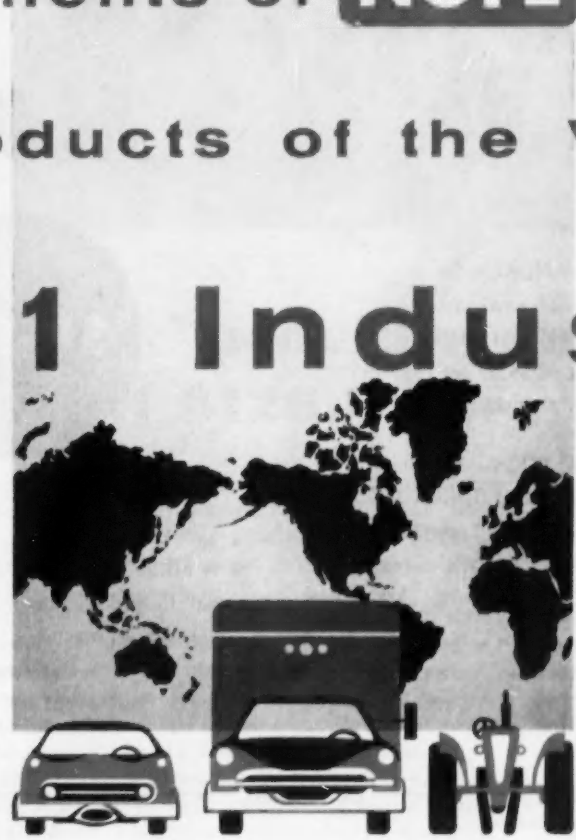

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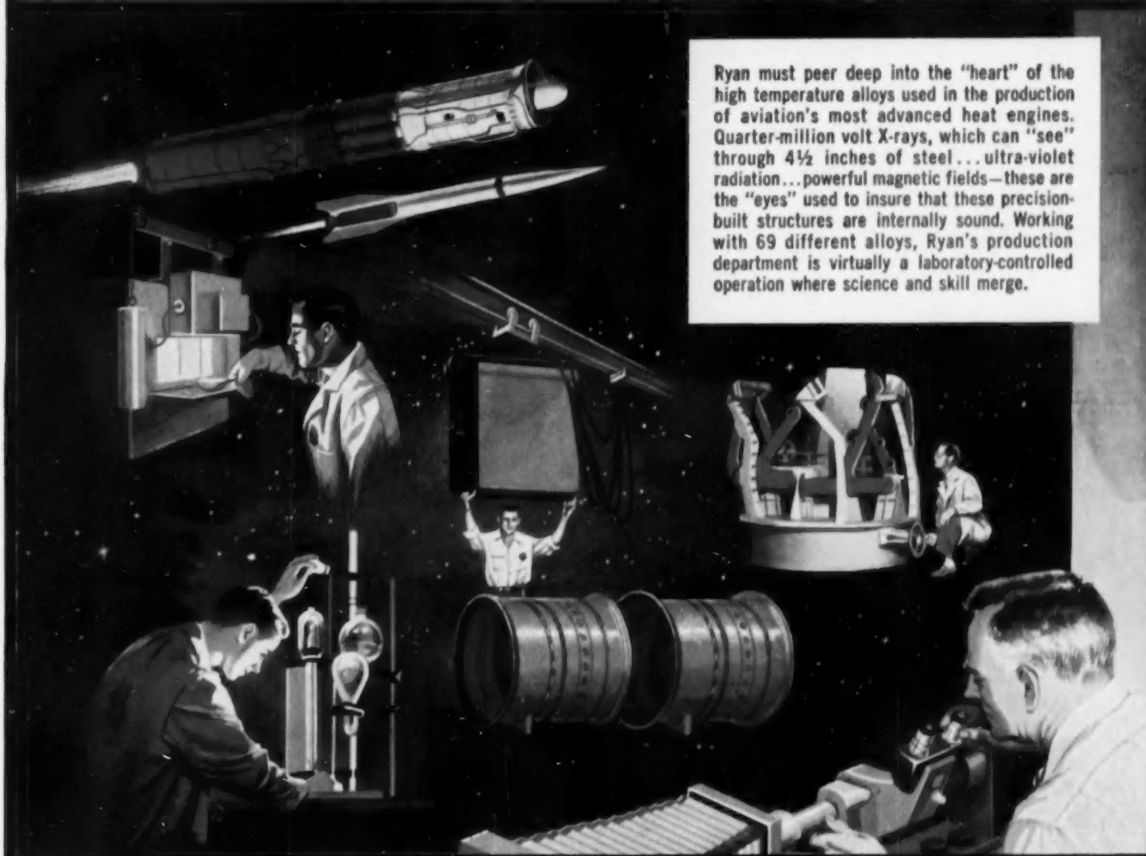

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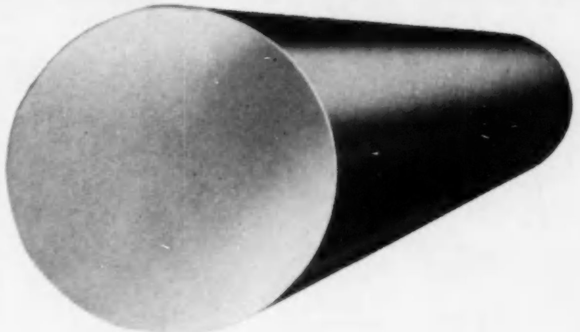

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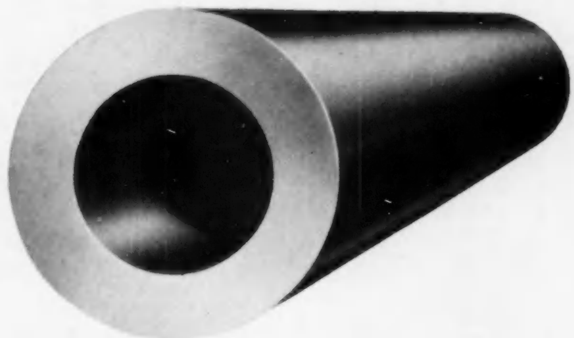

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